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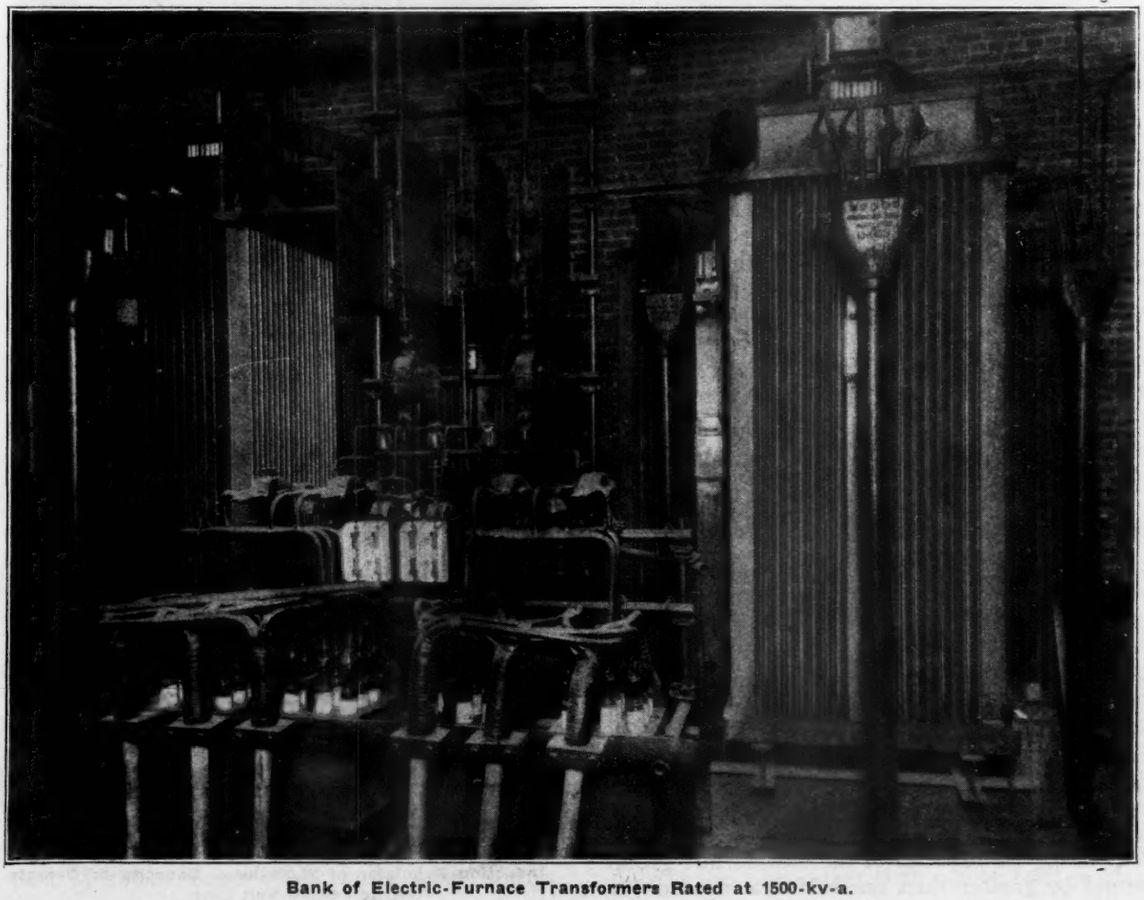
Factors in Selecting Transformers for Various Services

Character, Size and Duration of Load Are Important Considerations in Determining Transformer Capacity — Standardization of Sizes and Voltages Simplifies Selection of Ordinary Types of Equipment

By V. L. HOLLISTER

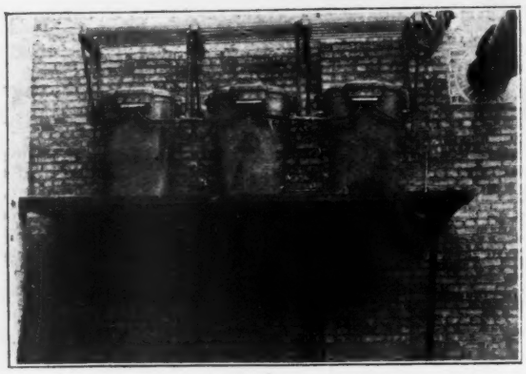
The size of a transformer to supply a load of a known value may be calculated accurately for present needs, but a study of local conditions, including such remote items as the extreme weather variations and the financial strength of the power consumer, must be the basis for the allowance made for future increase. For use in connection with single-phase motors the size of transformers should be figured in kilovolt-amperes, according to the accompanying equation, $(V \times A)/1000 = (Hp. \times 746)/(P \times E \times 1000)$, where V and A are transformer voltage and current, $Hp.$ is the load in horsepower, P is the full-load power-factor, and E is the full-load efficiency of the motor.

If a 10-hp. motor having a full-load power-factor of 83% is assumed, the equation would be $(10 \times 746)/(0.83 \times 0.84 \times 1000) = 10.7$ kv-a. and a 10-kv-a. unit would be selected. The same formula holds for the total transformer capacity needed to supply a two-phase motor from a two-phase circuit, or to supply a three-phase motor from a three-phase circuit by banking three trans-



Bank of Electric-Furnace Transformers Rated at 1500-kv-a.

formers in a delta or "Y" connection. Thus, to supply a 10-hp. motor, two 5-kv-a. transformers of the proper voltage rating on a two-phase system, or three 3.33-kv-a. units for a three-phase delta or "Y" system would be required. In instances where the motors are to operate at the



Bank of Small Power Transformers.

load figured for periods in excess of 0.5 hr., or continuously, the sizes of transformer as given above is correct; for intermittent operation, or for widely variable loads following a known cycle, other means must be employed to determine transformer sizes.

Special Conditions Require Special Treatment.

Where three-phase motors are operated from an open-delta or "V"-connected set of transformers it must be remembered that the group of transformers has a capacity of only 86.6% of the sum of the nameplate ratings. Hence, the kilovolt-ampere rating of the transformer group should be that shown by the equation, $(V \times A)/1000 = (Hp. \times 746)/(P \times E \times 0.86 \times 1000)$, where V, A, etc., have the same meaning as given before.

Keeping the latter and similar special cases in mind, but referring specifically to the general case as outlined at first, we have the following statement or rule usually given: "Install transformer capacity in kilovolt-amperes equal to the horsepower of the continuously operating connected load."

The power-factor and efficiency figures for motors may be taken from the accompanying table in absence of specific information. When a 10-hp. motor is operated at partial rating, say at 5 hp., it must be remembered that the power-factor will be materially less than it would be at full rated capacity. In the special case where transformers are to be installed for the operation of a large motor working at, say, one-half rating the capacity of the transformer group would be greater than one-half that needed for the full motor rating. Using the power-factor and efficiency at the partial rating for the particular motor in the above formulae will give the proper kv-a. of transformer capacity.

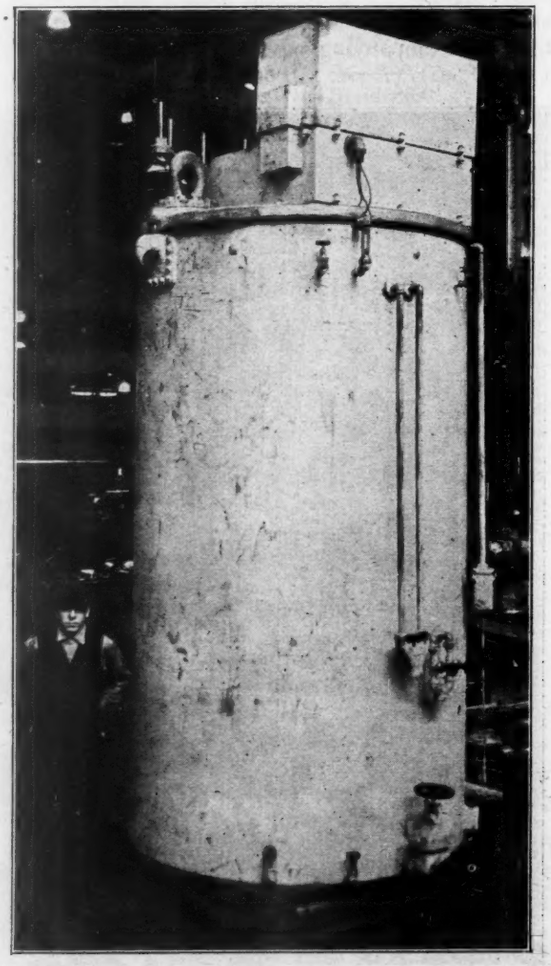
APPROXIMATE VALUES OF POWER-FACTOR AND EFFICIENCY FOR MOTORS OF VARIOUS SIZES.

Type of motor.	Rating in hp.	Power-factor.	Efficiency.
Single-phase induction motors....	1 to 5	80	80
	6 to 10	83	83
	15 to 25	86	86
Two or three-phase induction motors	1 to 5	80	80
	6 to 10	85	85
	11 to 20	88	88
	25 to 75	90	90

The selection of the proper size of transformer where the load varies widely in short intervals of time must be based upon the average heating over a complete period of the load variation. Such a selection can be made accurately only where the load varies cyclically. The calculation is best carried out by plotting curves of the current variation over one complete cycle or period. For the sake of illustration, assume a simple intermittent loading as shown in the accompanying table. Since the capacity of a transformer is limited by the heating produced by

ASSUMED LOADING CONDITIONS TO DETERMINE RELATIVE HEATING EFFECT.

Time period in minutes.	Amperes.	(Amperes)²
1	10	100
1	10	100
1	40	1,600
1	10	100
1	100	10,000
1	150	22,500
1	100	10,000
1	10	100
1	40	1,600
1	10	100
Total	490	44,200
Average	49	4,420
Square root of average		66.5



Induction Regulator of 20,000-kv-a. Capacity to Operate on 66,000-Volt Line.

energy losses, and since the heating is proportional to the square of the current, the average heat produced over a sufficiently long period of time must be determined in order to select the proper transformer for such service. In the second column of the accompanying table the average rate of current flow for each minute of time is shown, and in the third column is tabulated the square of the current. The averages of the current column and of the current-squared column are shown. The square root of the average of the current-square column represents a steady current value which would give the same heating as would be developed by the complex variable current assumed in this problem.

Assuming 2300-volt, single-phase operation, and basing the calculations on the average current of 49 amperes, a 112,500-volt-ampere transformer would be selected. A more nearly correct transformer would have a capacity of 66.5 x 2300 = 153,000 volt-amperes. However, in this case, due to the fact that the current reaches a value of 150 amperes, and this value is much greater than two times the value of 66.5 amperes, the calculations would be modified by considerations based on improvements of regulation and the provision of some spare capacity. A transformer of from 75 to 100-ampere capacity, or from 172,500 to 230,000-volt-ampere capacity should be chosen. In these calculations effective values of alternating currents and normal atmospheric temperatures are assumed.

In lighting service, and for similar loading, the transformer is operated practically on zero load during a large portion of the 24-hr. period. The power consumed by the transformer at such times is its iron losses only, plus a negligible copper loss. The copper losses are equal to the square of the current multiplied by the resistance, and become appreciable under load. An example will show the reasoning here better than description. Assume a 5-kv-a. transformer of a standard make rated at 2200 to 110 volts, and having an iron loss of 43 watts at all times while operating and a full-load copper loss of 92 watts. If this transformer operates for 4 hrs. per day at full load, and 20 hrs. per day at zero load, the input during the entire 24 hrs. would be 21,400 watt-hrs. distributed as follows: Iron losses of 43 watts for 24 hrs., totaling 1032 watt-hrs.; copper losses of 92 watts for 4 hrs., totaling 368 watt-hrs., and output of 5000 watts for 4 hrs., totaling 20,000 watt-hrs. The all-day efficiency is 93.5%, determined by the following equation:

Efficiency = output / input = 20,000 / 21,400 = 93.5%.

It is found in designing transformers that the ratio of iron to copper losses can be varied within limits, but the sum of the losses can not be lowered without sacrificing other desirable features and increasing expense. The manufacturers build distributing transformers with the copper loss twice the iron loss (approximate as above), and power transformers with practically equal iron and copper losses.

If a power type of transformer had been used in the example just worked out the figures would have been somewhat different. The total losses would be not less than 43 plus 92 watts, or 135 watts. Iron and copper losses would be equal to each other, and equal to one-half of 135 watts, or 67.5 watts. Iron losses for 24 hrs. would total 1620 watt-hrs., and copper losses would total 270 watt-hrs. Total losses for 24 hrs. would amount to 1620 plus 270, or 1890 watt-hrs. The all-day efficiency would be 91.3%, figured by the same equation as before, but using 21,890 watts as the input instead of 21,400 watts. The latter figure of 91.3% is a decided reduction in efficiency. In case the transformer in this example had been loaded for but 3 hrs. instead of 4 hrs. the difference in efficiencies would have been considerably greater.

Oil-Insulated, Water-Cooled, Three-Phase Transformer Rated at 3000 kv-a.

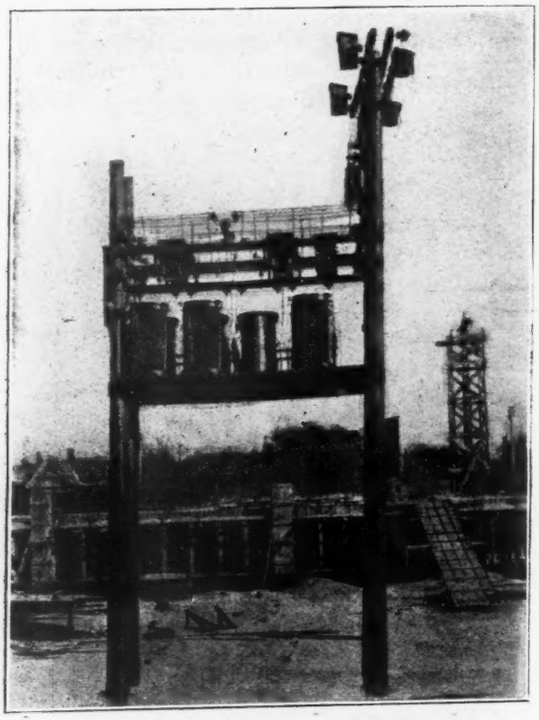
STANDARD TRANSFORMER VOLTAGE FOR DISTRIBUTION AT 600 VOLTS OR LESS.

Primary voltage.	Ratio.	Secondary voltage.
460	4 or 2	115 or 230
575	5 or 2.5	115 or 230
2,300	20, 10, 5 or 4	115, 230, 460 or 575
4,600	40, 20, 10 or 8	115, 230, 460 or 575
6,900	60, 30, 15 or 12	115, 230, 460 or 575
11,500	100, 50, 25 or 20	115, 230, 460 or 575
13,800	120, 60, 30 or 24	115, 230, 460 or 575
23,000	200, 100, 50 or 40	115, 230, 460 or 575
34,500	300, 150, 75 or 60	115, 230, 460 or 575

Classification of Transformers on Basis of Methods of Cooling.

Transformers are divided into classes, based on their method of cooling, as air-cooled, dry type; oil-insulated, air-cooled; oil-insulated, water-cooled, and air-blast transformers. The first class is manufactured only for small-power service or for instrument transformers. The second class embraces the vast majority of power and lighting transformers in use. In the larger sizes the oil is circulated by syphon action or is pumped through the transformer and auxiliary cooling tank. The third class is preferably used only in the sizes larger than can be built in class

two. This class is practically applied only where there is a cheap supply of cold water, such as in hydroelectric stations, or substations located on running water at the proper level. The last class is generally used in stations and substations where air-blast cooling can be supplied and maintained



Transformers With Multiple Voltage Taps for Street-Lighting Service.

more cheaply than any other cooling arrangement. Many such transformers have been installed where, in view of the rising costs of power, they are more expensive in the long run than transformers of the second or third class. The selection of transformers for a given service depends primarily upon size. One would not think

STANDARD TRANSFORMER VOLTAGES FOR DISTRIBUTION ABOVE 600 VOLTS.

Primary voltage.	Secondary voltage.
6,600	2,300
11,000	2,300
13,200	2,300
22,000	2,300
33,000	2,300

of air-blast or water-cooled transformers in sizes under 200 kw., and, in general, a much larger capacity would be necessary to justify installing such units.

Standardization of Sizes, Voltage Ratings and Taps.

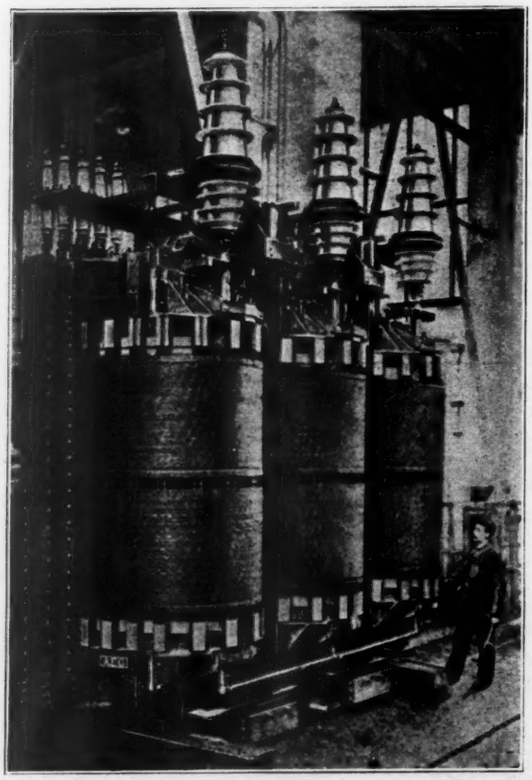
In June, 1918, the apparatus committee of the National Electric Light Association submitted a report proposing new standards for classifying transformers as to voltage ratings, sizes, tap connections, etc., which has been adopted by the manufacturers in general. Performance and temperature guarantees as prescribed by the American Institute of Electrical Engineers have also been adopted as standard.

In the case of distribution transformers the voltages of 460, 575, 2300, 4600, 6900, 11,500, 13,800, 23,000 and 34,500 have been adopted as standard.

All secondary voltages, with one exception, are integer divisors of these primary voltages, an accompanying table showing the various values. Standards in size of oil-immersed, self-cooled, single or three-phase transformers have been adopted to include equipment of 1, 1.5, 2, 2.5, 3, 5, 7.5, 10, 15, 25, 37.5, 50, 75, 125, 150 and 200 kv-a. capacity. All transformers rated at 2300 to 115 and 230 volts may be operated with the secondary windings either in multiple or series, and similarly for 230 and 460-volt secondary voltage ratings.

LARGE INCREASE SHOWN IN PUBLIC UTILITY EARNINGS.

October earnings reports of public utility companies indicate the effect of lower material costs and greater efficiency in labor. For the first time in months the majority of the principal utilities show an increase in both gross and net earnings, and all of them show a material falling off in operating expenses. The Cities Service Co.'s gross income for October was $481,189 more than that for the same month last year, while the net earnings amounted to $1,926,589, a gain of $485,693 over October, 1919. Gross earnings of the Columbia Gas & Electric Co. in October showed an increase of $273,241, or 29.7% over the same month last year; net operating revenues were $572,064, an increase of $145,378, or 34.06%. The Metropolitan Edison Co.'s October gross was $273,474, an increase of $68,808.



Three-Phase, 110,000-Volt Transformer of European Design.

Control of Power-Factor on Transmission Lines

Eleventh of a Series* of Articles Giving a Review of the Electric Power Situation — Objectionable Features and Causes of Low Power-Factor — Synchronous Machines and Static Condensers

By ALFRED STILL

There are many objections to operating an alternating-current power system on low power-factor. So far as the transmission lines are concerned, the current being greater for the same actual power transmitted when the power-factor is low, it follows that the line losses are greater on the lower power-factors.

The following formula, which neglects the capacity and inductance of the line itself, may be used to calculate the losses due to ohmic resistance of the conductors on any balanced polyphase transmission line:

Percentage power lost in any balanced poly-

$$\text{phase transmission} = \frac{W R_p}{E_n^2 \cos^2\theta} \times 100$$

where W stands for the total watts transmitted, E_n is the voltage measured at the receiving end between any one wire and neutral, and R_p is the joint resistance of all the conductors in parallel.

The losses are thus seen to be inversely proportional to the power-factor of the load. By lowering the power-factor from unity to 0.71 the line losses would be doubled when transmitting the same actual power.

The voltage drop also increases considerably with low power-factor, not only because of the greater IR drop caused by the larger amount of current, but also because the inductive drop comes more nearly in phase with the line voltage as the power-factor is reduced, and thus causes a greater difference between the pressures at the two ends of the line. A reactive drop of only 4% on unity power-factor would increase to 18% on a power-factor of 0.8. This point was referred to at the end of the preceding article and it will again be discussed.

Apart from the effect on the line itself, a low power-factor is objectionable from the standpoint of the generating plant. The size and cost of an electric generator is determined by its volt-ampere output and not by its output measured in terms of true watts. But large turboalternators and other alternating-current generators are limited in their output by the capacity of their field magnets. With low, lagging power-factors a large increase of excitation is needed to maintain the voltage at the generator terminals, and this leads to overheating of the field coils. Thus, on low power-factor the loading that a generator will stand is generally limited by the field-winding heating and the impossibility of maintaining the voltage at the alternating-current terminals. This is not true on unity power-factor loads, which are usually limited by armature heating or the capacity of the prime mover. It is often difficult to maintain good voltage regulation on low power-factor systems because a large range of exciter voltage is required which is not always satisfactorily taken care of by automatic regulators. Moreover, the field circuit is usually nearing a condition of magnetic saturation when heavy loads are taken from the machine at low, lagging power-factors, and the magnetic changes are slow to follow the changes in the exciting current.

We thus see that low power-factors lead to increased initial cost of plant and apparatus, increased losses resulting in lowered efficiency, difficulties of preventing field magnets overheating and in maintaining proper regulation at the station bus bars, and greatly increased pressure drop in the transmission lines.

Causes of Low Power-Factor.

Lagging current components lower the power-factor, and since all machinery or apparatus of which the magnetic field is produced by alternating currents drawn from the main system must have current components lagging 90 deg. behind the impressed e.m.f., it follows that every piece of apparatus of this type connected to the supply mains tends to lower the power-factor of the system.

Transformers, induction motors and all magnetic devices operated by alternating currents draw from the system lagging currents which increase the total current necessary to provide a given maximum amount of power, and further have the objectionable characteristic of demagnetizing the fields of the alternating-current generators. The magnetizing component of the total current in a well-designed static transformer is but a small percentage of the total current; but in the induction motor the magnetizing current, even at full load, is appreciable, owing to the reluctance of the necessary air clearance between stator and rotor, which calls for a large number of magnetizing ampere-turns on the stator. The wattless current component in an induction motor may be between 25 and 30% of the total current in the stator windings.

The greatly increased direct-current excitation of the generators because of lagging current components in the system may be thought of as supplying the magnetomotive force for those ma-

*Preceding articles in this series appeared in the July 17, Aug. 7, Aug. 21, Sept. 4, Sept. 18, Oct. 2, Oct. 16, Nov. 6, Nov. 20 and Dec. 4 issues of Electrical Review.

chines which are connected to the mains and require excitation, but are not provided with direct-current magnetizing windings. Thus, when the power-factor of the load is low, we may think of the currents in the generator field windings producing not only the flux necessary to generate the e.m.f. in the generator, but also supplying the magnetomotive force which, by the agency of the wattless current, is transmitted to the machines and apparatus which require excitation but are not provided with direct-current field windings.

Improvements in Alternating-Current Induction Motors.

The wattless component of the total current may be reduced by using motors which do not require strong magnetic fields or by providing these machines with independent excitation.

On 25-cycle systems the wattless currents are not so great as on 60-cycle systems, and the lower the frequency the smaller will be the wattless component of the power necessary to produce the alternating magnetic field. Suppose this field could be produced by a set of poles excited by continuous currents and caused to rotate at the same speed as the rotor, the frequency of the exciting current being zero, there would be no wattless component in connection with it, and the motor could operate at unity power-factor. It would be possible to go further and by over-exciting the motor with this imaginary direct-current winding *leading* instead of *lagging* current components could be injected into the alternating-current system. This idea is the basis of recent improvements in motor design and of the methods employed to improve the power-factor of the alternating-current power distributing systems. If in place of the imaginary system of separately excited magnets rotating at the same speed as the revolving field of the ordinary induction motor a device is employed to provide the excitation, not from the stator windings, but from currents supplied to the rotor windings at the very low frequency of the rotor currents, the same end may be attained. This is the means by which Leblanc in 1895 and Heyland in 1901 produced exciters and improved induction-type motors with power-factors in the neighborhood of unity. These methods involve a commutator on the rotor as well as brushes, with higher cost of manufacture; but good motors are now available to operate at unity power-factor on alternating-current circuits. The fact that the simple and rugged design of induction motor, with either squirrel-cage or wound rotor, is still the cause of low power-factors on alternating-current systems would seem to indicate that the last word has not yet been said on the subject of alternating-current motors with unity power-factor.

Prof. Miles Walker's "Phase Advancer."

Without going fully into the construction and possibilities of this device, it is so closely allied to the matter of improved motor design that a few words should be said about it.

Professor Walker first described his "phase advancer" in 1908. It is not a motor, but a machine of the type proposed by Leblanc, which will provide the exciting current to the rotor of an ordinary induction motor and so cause it to operate at near unity power-factor.

A three-phase machine of this type has an armature core similar to that of a direct-current motor, and has a commutator with three brushes. There are also three (or a multiple of three) poles wound with a main winding connected with the rotor circuit of the induction motor, and a compensating winding is placed in slots in the pole face to prevent field distortion and improve commutation. A machine of this kind will so modify the phase of the currents in the rotor that these currents will provide the rotating field, and wattless currents will not be drawn from the supply mains.

Notwithstanding the introduction of improved motors and phase advancers, the power-factor of many supply systems is very low, being frequently no higher than 0.8, and sometimes as low as 0.7. This is because such systems are supplying load through inductive transmission and distributing lines to transformers which, in their turn, are connected to a load which is not all non-inductive, but includes alternating-current arc lamps and induction motors without power-factor connecting devices.

Use of Static Condensers to Correct Power-Factor.

If the induced e.m.f.'s which produce lagging current components are balanced by equal but opposite e.m.f.'s which tend to produce leading current components, the power-factor of the system may be unity, notwithstanding the low power-factor of much of the apparatus connected to the lines. This suggests the use of electrostatic condensers to draw leading currents from the mains. This they would be able to do satisfactorily if they could be built of sufficient capacity and to withstand the high pressures of modern transmission systems at a reasonable cost. It is quite feasible to manufacture oil-cooled condensers for use on pressures up to 60,000 volts or even higher, but they are very costly, and not so reliable as other apparatus available to perform the same function. There is always danger of overheating through dielectric losses which are considerable in these high-voltage electrostatic condensers.

Over-Excited Synchronous Machinery for Power-Factor Correction.

Synchronous motors (as on motor-generator sets and rotary converters, where a continuous-current load is required) and synchronous condensers, the latter being merely "idle" motors, may all be used for power-factor correction.

It is well known that a synchronous motor when under excited will draw from the alternating-current mains lagging components of current which will provide the ampere-turns of excitation to maintain the flux in the air gap at the required amount. It therefore follows that if the direct-current ampere-turns are increased beyond what will produce the correct strength of field to provide the necessary back e.m.f. a *leading* current component will be drawn from the supply mains to demagnetize the field and keep it of the required strength. A small additional capacity will render any synchronous motor available for this service. If there are no synchro-

nous motors forming part of the load of a power system, synchronous condensers may be provided of sufficient capacity to supply, with over-excited fields, the e.m.f. necessary to annul the lagging components of current in the system. In such a case it is important to study the economics of the situation to be certain that the expenditure on such machinery will be justified on economic grounds.

It is not always necessary to bring the power-factor up to unity, as a power-factor in the neighborhood of 0.9 is not usually very objectionable. The very low power-factors are, however, uneconomical and undesirable. The rotary converter—which is, of course, only available where continuous currents are needed—has a high efficiency and serves admirably to correct the power-factor of the system.

A large wattless current may be needed to change the power-factor from 0.9 to unity, but only about one-quarter of this amount will change the power-factor from 0.8 to 0.9. That is why it may not always be desirable to aim at improving the power-factor beyond about 0.9. It has been shown that the control of power-factor is obtained by balancing any excess of inductive reactance with condensive reactance, or vice versa. With a changing load at the end of a long transmission line, the power-factor at any given point on the line is continually changing, even if the power-factor of the load remains constant; and the most convenient means of providing the reactance necessary to maintain a constant and improved power-factor is to install synchronous motors which can be made to draw leading or lagging currents from the line by over- or under-exciting their field magnets.

In Fig. 1, *B* is a synchronous generator connected as a "booster" and provided with field regulation in order to control the *voltage*. It is

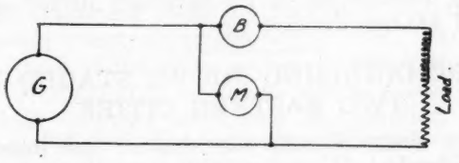


Fig. 1.

direct-coupled to the synchronous motor (*M*) which is provided with field regulation in order to control the *power-factor*. The machine *M* serves exactly the same purpose as would a static condenser connected across the lines. Let us now consider how, when it is not necessary to control power-factor independently of voltage, the single machine marked *M* in Fig. 1 may be used for voltage control without the addition of the second machine, *B*, connected in series with the line.

Use of Synchronous Reactors to Control the Voltage.

In the preceding article it was shown that, by altering the power-factor of the line, the changed phase relations of the various e.m.f. components will lead to a change in the line drop. In other words, by changing the power-factor—or the phase difference between the line current and e.m.f.—the inductance of the line and of such apparatus as transformers connected thereto can be utilized to provide the required voltage component. This is best explained with the aid of vector diagrams.

In Fig. 2, the regulation diagram of a transmission line has been drawn, with the total pressure drop (*OD*—*OB*) indicated by lines showing separately the "in-phase" and "wattless" components of the total line current. Thus, if E_n, *I*, and cos θ stand respectively for the "star" voltage, the line current, and the power-factor at the receiving end, the *IR* and *IX* drops due to the "in-phase" component, *ON*, of the current are

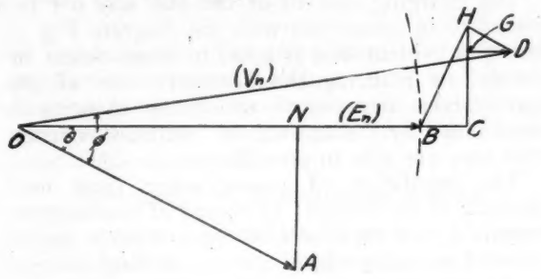


Fig. 2.

CB and *HC*, respectively, while the *IR* and *IX* drops due to the "wattless" component, *NA*, of the current are *GH* and *DG*, respectively. The pressure necessary at the generating end is $V_n = OD$, and the pressure drop is $DF = V_n - E_n$. If, now, we can—by means of over-excited synchronous machinery—so change the power-factor that the point *D* will fall on the dotted circle of radius *OB*, we shall obtain the condition of constant voltage, i. e., the same voltage at the generating as at the receiving end of the line.

Assuming no change in the load current *I*, the impedance triangle *BCH* will also remain unaltered; but by drawing a leading "wattless" current from the line the current component *NA* can be not only annulled but actually reversed, thus making the line current *lead* the receiving-end voltage, thereby changing the voltage *drop* due to the reactive component of the current into a voltage *rise*. This is shown in Fig. 3, where the excitation of synchronous reactors, connected across the line at the receiving end, has been increased until the leading component of the line current is equal to *OK*. The resultant current is *OM*, with a leading "wattless" component *NM*, giving the impedance triangle *HGD*, which throws the point *D* on the dotted circle and makes $V_n = E_n$.

This is the principle of constant-voltage transmission with the pressure regulation obtained by providing the necessary number of variable-field synchronous motors at suitable points on the transmission line, but mainly at the receiving end where the heavy load is taken off. By this method, the reactance of a long line—usually an objectionable feature tending to limit the size of individual conductors—is actually necessary to the proper regulation of the voltage. The machines used as synchronous condensers may be synchronous motors from which mechanical power is obtained, or they may be rotary converters or machines specially designed for no other purpose than to regulate the amount and direction of the "wattless" current, in which case

they would be installed in the receiving point substations and would be run "idle." The power-factor will not necessarily be unity, but the improvement in the power-factor will generally permit of more energy being transmitted along a given line than would otherwise be permissible or economical. The most economical cross-section of conductor may be used without regard to pressure drop, because where a drop of 10 to 15% would be about the upper limit with the older systems of regulation, a drop of 25% (due mainly to the inductance of the line) can be taken care of by synchronous reactors.

The charging current of the line was not referred to in connection with the diagram Fig. 3, but it is evident that it must to some extent be helpful in reducing the necessary size of the synchronous motors, of which the capacity is determined by the amount of "wattless" current that they are able to provide.

The regulation of power-factor (and incidentally of the voltage) by means of synchronous motors is not applicable to short-distance small-power transmissions, and even on long-distance

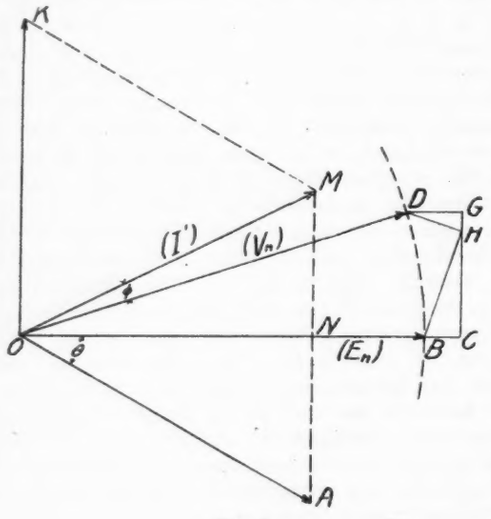


Fig. 3.

lines transmitting large amounts of energy, the engineer should be careful to consider the whole problem from the economic point of view: there are a great many factors to be taken into account, among which reliability of service and maintenance costs are not the least important. A notable instance of voltage control by this method is the transmission line from the hydroelectric plant at Point du Bois in Canada to the city of Winnipeg where two 6000-kv-a. synchronous motors with automatic regulation are installed for the sole purpose of regulating the voltage by power-factor control; the line pressure at the generating station remains constant.

Before deciding to install synchronous machinery to control the voltage and power-factor of a transmission line, it is important, as already mentioned, to consider the increased cost due to such machinery over alternative methods of pressure control, and compare this with the capitalized cost of the saving in transmission and other losses due to the improved power-factor. A point which should not be overlooked is the possibility of synchronous machinery falling out of step, and so causing troubles and interruptions to supply which are best avoided by installing no auxiliary apparatus which it is possible to do without.

CHRISTMAS SELLING CAMPAIGN OF S. E. D. IN FULL SWING.

The holiday campaign of the Society for Electrical Development is in full swing, and the Christmas selling slogan, "Say Merry Christmas Electrically" is being spread broadcast by central-station companies and electrical merchants taking part in this movement. The society has conducted many campaigns in the past, but from present indications this 1920 Christmas drive promises to eclipse all previous selling movements. As in previous campaigns, the society supplies a certain amount of advertising material free to its members. Non-members, however, are required to pay only the actual cost of producing and distributing the material which they may want to use.

INSURANCE POLICY AS CHRISTMAS GIFT FOR EMPLOYES.

A life insurance policy with the premiums on it paid by the company is the Christmas present which employes of the Public Service Co. of Northern Illinois who have been in its service longer than three months will receive during the holidays. This substitute for the usual turkey was made dependent on the choice of the employes as expressed in a general vote taken last month. More than 1750 individuals will receive policies, the amounts ranging from $500 to $1500, according to the holder's length of service. The policies are issued under the group-insurance plan. The cost to the company in premiums and in the preparation of the necessary details will equal $24,000 the first year.

MERCHANDISING SHOWS STAGED IN TWO EASTERN CITIES.

The electrical contractor-dealers and jobbers of Columbus, O., and vicinity were given an opportunity of attending a "Better Merchandising Show" at the Hotel Chittenden Nov. 30. and Dec. 1-2, given by Hughes, Peters & Co., Columbus. Shows were also given at the Hotel Taft, New Haven, Conn., Dec. 4-8, under the auspices of the Hessell-Hoppen Co. The Westinghouse Merchandising Bureau is arranging for exhibits in some of the large western cities after Jan. 1.

RADIO DEVELOPMENT DISCUSSED AT A. I. E. E. MEETING.

Arthur E. Van Dyck, Radio Corp. of America, New York City, addressed the Pittsburgh Section of the American Institute of Electrical Engineers Dec. 14 on the subject of "A Transition Period in Radio Communication." The speaker outlined the development of radio by periods and the effects of such developments on long and short-distance communication, radio telephony, direction finding and the use of radio devices in other arts.

Economies in Power-Plant Operating Practice

Moderate Superheat and Good Vacuum Necessary — Trained Boiler-Room Men an Essential Element in Operation—Paper Before Southeastern Division, National Electric Light Association

By C. A. GREENIDGE

Chief Engineer, J. G. White Management Corp., New York City.

The objects of power-plant operation, or the reasons we have such mechanical aggregations, are two in number—to render service and to produce profit for investors. In fulfillment these two are intimately connected. Plants must render service in order to produce profits and, conversely, plants must obtain profit from this service in order to continue to render proper service. To render service means to satisfy the requirements of each customer—not merely the maximum output at minimum cost, but the maintaining of an ample supply, close frequency, proper voltage and assured continuity are necessary for real efficiency.

To attain these objects requires a co-operation between engineering foresight and competent direction on the part of the management and conscientious labor on the part of the employes. This concerted action should be directed toward the increase of quality of service and the reduction of the costs of production. The tangible elements in service, or the outward visible signs, are the constant brilliancy of the lamp, the constant speed of the motor and the continuity of service. The first two conditions indicate constant voltage and unvarying speed of the prime mover—the former greatly dependent on the latter. Variation in speed of the prime mover, excluding that due to overload, may be due to several causes all of which indicates inefficiency in operation. The cause may be governor trouble which can be easily remedied. In many cases it is due to fluctuating steam pressure. Assuming that the boiler capacity is ample for the load to be carried, fluctuation in steam pressure may be due to poor firing, improper regulation of air supply or uneven supply of boiler-feed water. The first two causes are the more difficult to remedy because of the poor material available for boiler-room service in this territory. For this reason a greater responsibility for the economical use of fuel rests on those in charge of plant operation than in districts where more intelligent help is obtainable, and makes closer boiler-room supervision imperative. The uneven supply of feed water can be remedied by the installation of feed-water regulators, many good types being available. An even supply of feed water results in feed water of even temperature, higher efficiency in boiler operation, and more economical use of exhaust steam used for heating the water. In the case of condensing plants equipped with surface condensers uniform feeding of boilers avoids waste of condensates. The installation of feed-water regulators is sometimes objected to because the fireman becomes dependent on it. Like every other boiler-plant auxiliary the feed-water regulator needs attention.

Efficiency or Economy of Service.

The economy obtainable in plant operation is intimately tied up with the losses, both preventable and nonpreventable, in the production of the service. If we list the losses in the average boiler room we get some idea of their proportions, but it is safe to say that the total losses are seldom less than 25% in medium-size boiler plants.

Efficient operation of the boiler and the ample supply of steam to the prime mover are dependent on still other things. In the past boiler settings have been made so low that the gases reached the comparatively cold flues or shell before combustion had taken place, and the results have been plenty of smoke and little steam per pound of fuel. Besides being inefficient in operation these conditions have caused unfavorable comment in our communities. The companies with which the writer is connected are now setting all water-tube boilers of the horizontal type with the front headers at least 9 ft. 6 ins. from the floor, so as to largely increase the combustion space.

Good furnace design, however, will be of little avail if cracks in boiler settings are allowed to remain open, baffles to remain warped and burned out, and tubes to remain covered with soot. The question of sufficient draft is very important. While it is possible to have excessive draft, this is exceptional, and in the past in a great majority of cases the draft has been insufficient.

Boiler-Feed Water Requires Special Treatment.

After all has been accomplished that is possible in improving the combustion of the fuel and delivering its heat to the boiler tube the next care is with the inside of the tube. In its raw state hardly any water is good enough for boiler feed without purification. The proper treatment to be applied must be determined for each individual plant. Boiler compounds cannot be depended on for universal relief, since water differs in different localities and its quality varies from time to time so that a chemical preparation which is effective in one place will probably not be effective in another. Even when used at the

same place over an extended priod a given compound will fail to give uniform results. The only sure way is to have frequent analyses made and apply the remedies which those analyses show to be necessary. In Florida water is found which contains as high as 50 grains of incrusting solids per gallon, and deposits a dense hard scale on the tube surfaces. In some places surface water from shallow wells or ponds is available. This water in some cases can be used successfully alone, but in others contains so much tannic acid that it is necessary to neutralize it by mixing it with deep-well water. Another method of avoiding scale in condensing plant is the evaporation of the make-up water. The cost of this method may be derived from an accompanying table.

STEAM REQUIRED TO EVAPORATE MAKE-UP WATERS.

Arrangement.	Lbs. distillate produced per lb. of steam.
Quadruple effect	2.81
Triple effect	2.28
Double effect	1.65
Single effect	0.90

Losses in heat transmission will increase with the thickness of scale, and for thicknesses up to 0.125 in. such losses may reach 12%. It has been found that a thin film of grease is more harmful than thick scale, because it prevents contact between the water and the boiler surfaces, and every effort should be made to extract oil and grease from exhaust steam used for heating feed water. The installation of oil separators with open feed-water heaters will give relief, but this piece of apparatus must be inspected in order to get the best results.

The chief item entering into cost of power production is fuel, and most of our energies in behalf of economy should be directed toward this item of expense. The power-plant personnel should be urged to study the economical combustion of fuels. The day when any man who could wield a shovel was good enough to be a fireman has gone by, and it is necessary to concentrate attention on the biggest item of expense and select men for the boiler room with as much care as is used in selecting men for the engine room. Cheap labor in the boiler room is the most expensive help to be had, and, as Harrington Emerson says, "Wastes occur because modern industrial activities are undersupervised, therefore, have to be overequipped." While replacing the man's muscles with a piece of coal we have not yet learned that the man's brains and conscience are needed to supervise the acquirement, the transportation and the use of that piece of coal.

Fuel Is Largest Item of Expense in Power-Plant Operation.

Since fuel is the largest item care should be taken to see that the money expended for it purchases heat and not simply weight. The heat in a pound of coal from different mines can vary as much as 100%. In this connection it is of interest to note that the heat in a barrel of fuel oil will not vary 8% over a wide range of gravity.

The necessity for covering all live and exhaust steam piping is too well-appreciated to call for extended comment. However, it is known that even with the most efficient covering there must be some condensation. The ill effects of wet steam on the economy of both the reciprocating engine and the turbine, and the erosive action of wet steam on turbine blades, are well known. To overcome these difficulties it is believed that a moderate amount of superheat, say at least 75 deg. F., should be added to the steam so that the prime movers may be assured of dry steam.

Economies effected by high vacuum in the operation of prime movers, and especially in turbines, are well known facts. It is necessary therefore that every effort be made to maintain as high a vacuum as circulating-water conditions will permit, and to meet the conditions with which we have to contend in Florida surface condensers are used. Condensing equipment when new and clean may be ample, but if tubes become clogged both the condensing surface and circulating water are reduced and low vacuum results. The circulating water available begins to deposit scale at a temperature of about 180 deg. F., corresponding to a 14-in. vacuum, but at lower temperatures and correspondingly higher vacuums the deposit is a soapy sludge which can be removed by washing.

Air Leaks Cause Low Vacuum.

The usual reason for low vacuum is air leakage, and frequent inspection should be made of all points at which air can be drawn in such as piston rod, stuffing boxes and joints in exhaust piping. In turbine operation every loss in vacuum must be guarded against, as under uniform conditions of steam supply a variation of 1 in. in vacuum will increase the steam consumption 3 to 6%, with corresponding or greater variation in fuel consumption. At full load a considerable part of the turbine is under vacuum, and at light loads practically all of it is. Consequently frequent attention should be given to gland and seal and turbine casting joints; leaks have also been found in porous castings, drains, bolt holes, etc.

HEAT LOSSES IN AN AVERAGE BOILER ROOM.

Source.	Loss in per cent.
Handling fuel at plant	1.0
In ash	3.9
Radiation	2.9
Incomplete combustion	0.7
Air leakage in furnace and boiler	9.8
Excess air through grates	9.8
Short-circuiting of gases in gas passages of boiler	1.1
Soot on heating surface	3.9
Scale in boiler	5.0
Incorrect amount draft for load	3.8
Leakage of water and steam	0.7
Total preventable or reduceable losses	42.6

The plant auxiliaries are the little things on which continuity of service often depends, and they should receive the same careful and frequent inspection as is given to the main units. Exciters, boiler-feed pumps and hot-well pumps deserve careful consideration if continuous service is to be rendered. Their location in the plant is of great importance; they should be easy of access and whenever possible should be in plain view. If they are in dark or relatively inacces-

ELEMENTS OF POWER-PRODUCTION COST IN VARIOUS PLANTS.*

Plant No.	1	2	3	4	5	6	7†
Fuel, %	51.2	61.8	67.9	68.7	70.4	75.0	69.0
Labor, %	29.5	18.8	11.0	19.4	17.9	17.4	18.0
Maintenance, %	15.8	14.3	17.3	6.7	8.1	3.5	9.0
Miscellaneous, %	3.5	5.1	3.8	5.2	3.6	4.1	4.0
Fuel used	Oil	Coal	Oil	Coal	Oil	Coal	
Annual output, kw-hr.	705,570	681,230	1,604,430	2,208,220	1,710,410	4,347,400	

*All figures are for past 12 months.

†Average of large plants with an output of approximately 79,000,000 kw-hr. per year.

sible places they will be neglected and may fail to operate at a critical moment.

INSTRUMENTS INDICATE OPERATING CONDITIONS.

Instruments for the boiler and engine room which give a comprehensive view of operating conditions have been sadly neglected till quite recently, and even now a large amount of steam is generated with the aid of no other instruments than a steam gauge and gauge glass. The instruments which tend to give the operator a strong grasp on varying conditions are really sign posts on the road to economy, and when properly used are very worth while investments.

Among the most deserving of installation are the draft gauge, connected so as to read furnace, ash pit and uptake pressures and the drop through the boiler; the pyrometer to read flue-gas temperature, one instrument being connected to serve a number of boilers; the CO_2 recorder, or, where expense prevents, an Orsat; a thermometer in the feed line; some method of determining the weight of coal and ash, and a steam flow meter.

By the use of the indicator varying conditions in engine operation can be detected and corrections made. The vacuum gauge, preferably a mercury column, and thermometers for indicating the inlet and discharge temperatures of the condenser circulating water are of great assistance in the efficient operation of the condenser and its auxiliaries.

ESSENTIAL RECORDS SHOULD BE KEPT.

Only such records should be kept as will be really useful. There is a tendency among some operators to require the power-plant employes to keep numerous records, most of which are filed away and never consulted afterwards. A graphical record wherever it is possible to use such a form is favored because it presents to the eye of the employe, much better than a column of figures, any change that may take place. It is of primary importance that accurate record should be kept of output and fuel. A continuous record of fuel burned, water evaporated and output is of far greater value in showing production cost and condition of equipment than any spasmodic tests of apparatus no matter how thorough the latter. Important boiler-room records are quantity and temperature of feed water, boiler pressure, draft and temperature of gases leaving boiler, time of cutting in and cutting out boilers, when and how long boilers were blown down. Important engine-room records are load carried, vacuum, temperature of circulating water entering and leaving condenser and hot-well temperature. Time of starting and stopping units should also be recorded.

About 15% of the heat in the coal delivered to the power plant is lost nonpreventably in the boiler; approximately 80% of this is lost in the chimney in maintaining draft. An accompanying table shows the distribution of actual heat losses in an average boiler room.

SOOT PRESENT IN AIR IN LARGE QUANTITIES.

Measurements made in Leeds, England, indicate that factories and domestic chimneys annually introduce into the atmosphere of that city 35,000 tons of soot and into the atmosphere of the United Kingdom 2,420,000 tons. The measurements also show that there are 200 lbs. of soot suspended in the air over each square mile of Leeds, that about 11% of this falls in the immediate region where it is generated, and that the remainder is carried to considerable distances before it is deposited. By means of soot gauges and from the analysis of rainfall and snowfall, fairly accurate determinations have been made of the rate of deposit of soot at different points on the British Isles. The accompanying table gives some of the results.

TABLE SHOWING RATES OF SOOT DEPOSIT IN VARIOUS LOCATIONS.

Place.	Tons per year per square mile.
Industrial center of Leeds	539 tons
Suburban residence section of Leeds	26 tons
Center of London	426 tons
Sutton, Surrey, just outside the metropolitan area	58 tons
Glasgow	820 tons
Small seaside village	72 tons

Similar measurements made in the city of Pittsburgh showed that the rate of deposit in that city varied, according to location, from 595 to 1950 tons per year per square mile.

TELEPHONE FINANCE DISCUSSED AT ELECTRICAL MEETING.

At a meeting of the New York Electrical Society held Dec. 15 in the Engineering Societies building, New York City, H. J. Carroll, New York Telephone Co., gave an address on "The Telephone, as It Is and Is to Be," in which he discussed the question of telephone finance and its bearing on the future of the telephone service.

OKLAHOMA UTILITY BUREAU ISSUES FIRST NEWS LETTER.

The Public Utility Information Bureau of Oklahoma, of which H. A. Lane, 1107 First National Bank building, Oklahoma City, is manager, has issued its first news letter. It consists of suggested newspaper items on public utility activities, traction and telephone news and other matters affecting utility service.

Control Equipment for Direct-Current Motors

Fourth of a Series of Articles on Principles and Application of Motor-Control Apparatus — Dynamic Braking — Design of Controller Governed by Duty—Advantages of Automatic Control

By G. J. KIRKGASSER and E. W. SEEGER

Dynamic Braking Used for Quick Stopping.—On pumps, fans and such installations it is not usually necessary to stop the motor quickly, and after power is shut off the motor is allowed to drift until it comes to rest. On other types of equipment such as elevators, hoists and some machine tools it is necessary to stop the machinery as quickly as possible after power is shut off. In some cases hand-operated brakes are used; in others electrically operated mechanical brakes are installed. Where the machine must merely be stopped quickly, and where a mechanical brake is not necessary for holding the load, straight electrical or dynamic braking may be employed. Dynamic braking is also sometimes used in combination with a mechanical brake.

Fig. 19 shows a simple method of obtaining dynamic braking. When the single-pole, double-throw switch indicated at *M* is thrown from the upper to the lower position the motor is disconnected from the supply circuit and the armature is shunted by the resistance *R*. The motor will then act as a generator and impress voltage across the resistance *R*. The power generated in this way must, of course, be supplied by the stored energy of the machine, which is quickly brought to rest. The stopping time can be adjusted by changing the ohmic value of the resistance *R*. If the resistance is increased the current is decreased, which means a reduction in braking torque; therefore the stopping time will be increased. It is possible to arrive at the same conclusion from the standpoint of energy. If the current is decreased the watts (I^2R) dissipated by the resistance *R* will be decreased, and it will therefore take longer to dissipate the total stored energy of the machinery.

The voltage generated by the revolving armature is proportional to the speed, and as the motor speed decreases the voltage and the current are reduced. The braking torque is therefore directly proportional to the speed, while the watts dissipated in the resistance varies as the square of the speed.

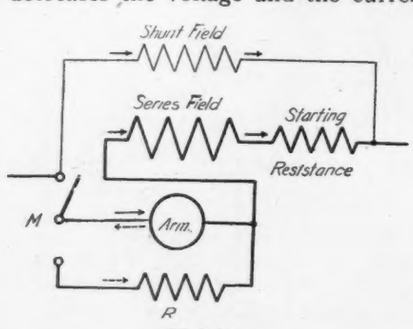


Fig. 19.

Across-the-line diagram showing connections for obtaining dynamic braking when the shunt field is across the line.

Shunt-Field Connections for Obtaining Dynamic Braking.—In Fig. 19 the shunt field is shown connected across the line, and this is probably the simplest and best method for obtaining dynamic braking. It often happens, however, that the shunt field is not designed for continuous service. In other cases, where the motor operates infrequently, the power loss in the field during the idle periods is quite an item.

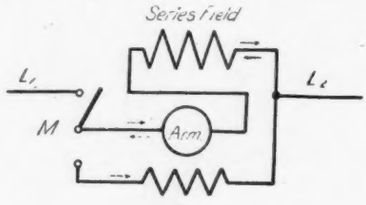


Fig. 20.

Across-the-line diagram showing connections for obtaining dynamic braking.

When it is not possible to connect the field across the line continuously a resistance is sometimes inserted in series with the field in the "off" position of the controller. This decreases the heating effect, but also reduces the braking torque. It is possible by means of relays to obtain full field strength for dynamic braking, and either weaken or disconnect the field at the end of the braking period.

Series-Field Connections for Obtaining Dynamic Braking.—The connections for obtaining dynamic braking on a series motor are usually more complicated than for a shunt machine. The reason for this can be seen by referring to Fig. 20. When the motor is running the circuit is from L_1 through the "up" contact of the switch *M*, through the armature and series field to the line L_2, as indicated by the full-line arrows. The counter e.m.f. of the motor opposes the line voltage, and when the motor is disconnected from the line the armature will tend to make the path of the current around the circuit indicated by the dotted arrows. The current of the series field, however, will be reversed, the field demagnetized and no dynamic braking obtained.

It is apparent that if the series-field connections are reversed for braking the path of the current is through the winding in the same direction as when the motor is running, and it will then be

possible to obtain satisfactory dynamic braking.

Fig. 21 shows one method of reversing the series-field connections. The full-line arrows indicate the direction of the current while the motor is operating and the dotted-line arrow indicate the direction of the current during the braking period.

The series field is sometimes connected in series with a resistance and across the line for braking. This method is expensive, because in order to obtain full field strength it is necessary to draw full-load current from the line.

Graduated Dynamic Braking.—Although the braking torque can be adjusted by varying the braking resistance it is not always possible to obtain good results with one step of resistance. As

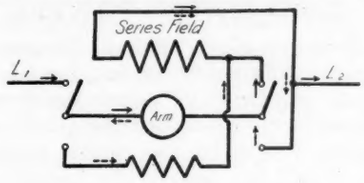


Fig. 21.

Across-the-line diagram showing connections for obtaining dynamic braking on a series motor.

the resistance is decreased the current is increased, and a point may be reached where the value of the current is high enough to cause commutator trouble. As the current is increased the torque is also increased, and if the braking torque is too high the machine may stop with a jerk. For this reason more than one step of braking resistance is sometimes used, with a comparatively high total resistance, which is reduced as the motor slows down.

Controller Duty Governs Design.—The design of a controller, whether it is of the manual or automatic type, is determined by the service for which it is to be used. It is obvious that if a controller is merely used to start a motor occasionally the resistor will not need to have as much capacity as it would for speed-regulating duty.

For ordinary starting duty it has been found that satisfactory results can be obtained if the resistor is designed to be in circuit 15 seconds out of every 4 minutes. For an automatic starter it has been found necessary to design the resistor for 30 seconds' duty out of every 4 minutes. Elevator service is still more severe, and for this duty the resistors are assumed to be in circuit 1 out of every 4 minutes. For mill duty resistors are designed for half-time duty, and speed regulators must be designed for continuous duty.

The contacts and connections can also be smaller where a controller is used for starting duty only. On the running point full-load current capacity is necessary, but on the intermediate points smaller capacity parts may be used. An example of this is found in the largest sizes of hand starters where the intermediate contacts are made by a shoe sliding over a copper segment. The running contact, however, is usually made of a copper-leaf brush.

Methods of Controller Operation.—Controllers can generally be placed in one of two classes, depending on the method of operation. Manual controllers are those in which all of the functions of the controller are directly under the control of the operator. Automatic equipments are those in which some or all of the functions are independent of the operator. Manual controllers have been more common than the automatci types, and are used principally because of their simplicity and lower first cost. Speed regulators are generally manually operated. For small motors which are started infrequently manual starters are usually satisfactory. Automatic controllers, however, have a number of distinct advantages over the manual types.

Automatic Controllers Offer Advantages.—When a manual controller is used it is possible for a workman to operate the controller so rapidly that the motor is practically connected to the line without resistance in series, and damage to the motor may result. With an automatic controller the acceleration of the motor is independent of the operator, and there is less possibility of abusing the motor and the machinery which it is driving.

Safety is, of course, one of the most important considerations, and if an automatic starter is used there is no necessity for the operator to come in contact with live parts. The same protection can be provided with a properly inclosed manual starter.

It is often possible to save valuable floor space by using an automatic controller which may be placed at any convenient point with only a push-button station or other control device placed at the machine.

When an automatic starter is used the operator merely presses a button and the motor starts and accelerates, while with a manual controller it is necessary for the workman to operate the controller handle until the equipment is up to speed. The automatic equipment not only saves time but allows the operators to give his undivided attention to the machine.

When automatic controllers are used it is a comparatively simple matter to add safety devices for the protection of the operator, motor and driven machine. Limit switches, emergency stopping stations, overload relays, etc., can be connected in series with the trip-coil circuit of the starter.

The use of automatic starters often eliminates the necessity for an attendant. This is especially true of air-compressor and pumping installations. On a pumping equipment the starting and stopping of the equipment is governed by a float switch or pressure switch.

It is sometimes necessary to have the point of control some distance away from the motor. If a manual controller is used under these conditions it is necessary to carry the main current from the motor to the point of control, and the cost of copper in this case would be excessive. If automatic control is employed it is only necessary to run pilot wires between the point of control and the motor.

On extremely large equipments, and on medium size equipments which are started frequently, automatic starters are often used because a manual equipment would be hard to operate, while an automatic controller can be operated from a push-button station or master switch.

Overload Protection.—Nearly every motor

and controller is provided with a service knife switch and fuses, and in a great many cases these fuses are the only overload protection used. Fuses are objectionable because in case of overload it is necessary to go to the switchboard and replace them. The expense of renewals has also been a considerable item, but since the advent of the renewable fuse this is not so serious.

Circuit-breakers are sometimes used in preference to knife switches and fuses, and positive protection can be obtained in this way. The ordinary circuit-breakers, however, trip out on momentary peaks of current which do not damage the motor. A circuit-breaker must either be provided with some means of preventing tripping on momentary currents or set so high that it affords no protection from continuous overload. It is now possible to obtain breakers with time-limit attachments, and if these are used the tripping point can be set low enough to protect the motor.

The use of relays for overload protection is quite common. When used with manual controllers the relay opens the circuit of the no-voltage release coil, and on automatic controllers the relay usually opens the coil circuit of the main magnetic contactor. Further discussion of overload relays will be given later.

CONTRACTOR-DEALERS OF IOWA TO MEET IN DAVENPORT.

The Iowa State Electrical Contractors and Dealers' Association will hold a meeting in Davenport the latter part of January. Louis L. Corry, Davenport, was named chairman of the general committee on arrangements; F. Thomas Turner secretary, and R. L. Stiles, treasurer. E. Kunkel will be in charge of the program and F. E. Downing will look after the entertainment features.

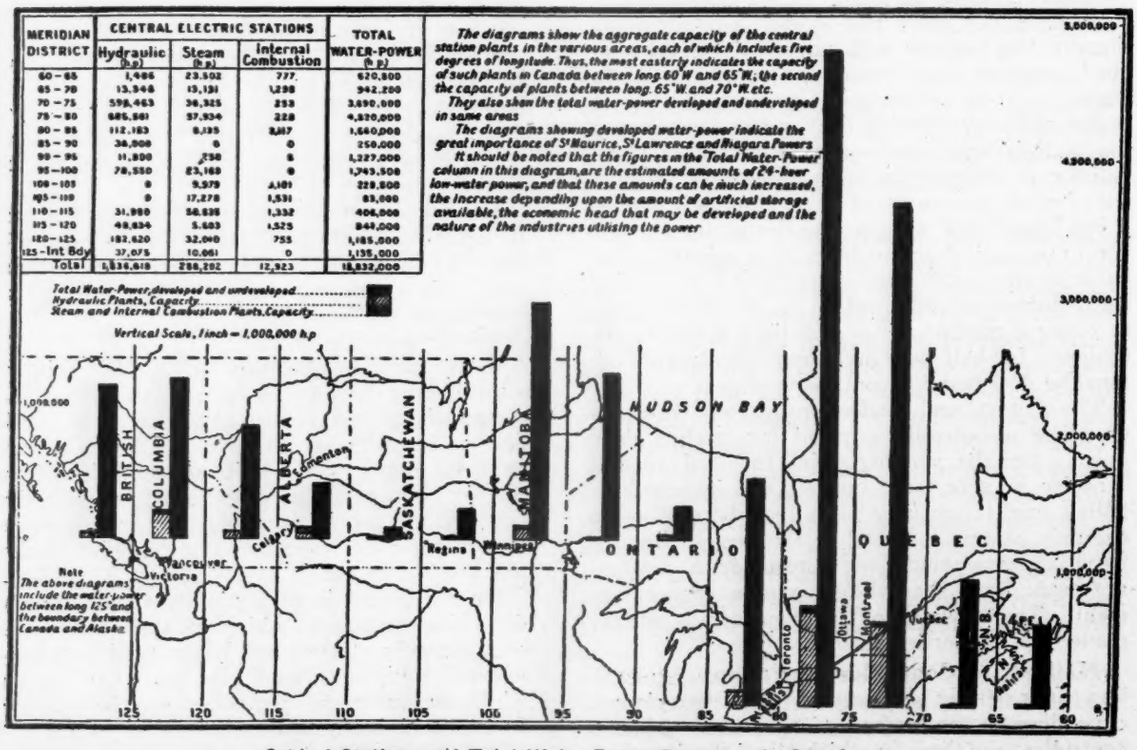
INDUSTRIAL PROBLEM DEBATED AT ELECTRICAL MEETING.

A mass meeting of the electrical industry was recently held at the Academy of Music, Philadelphia. The meeting was for the purpose of securing better relations between employers and employes in the industry, and was addressed by men prominent in the public affairs of the city. Washington Devereux, chief electrical inspector of Philadelphia, presented a resolution on behalf of the Electric Club of Philadelphia, asking for greater co-operation between employers and employes.

CANADA RANKS SECOND IN DEVELOPED WATER POWERS.

According to a recent study of the water-power resources of different countries, Canada has the greatest per-capita water-power development of any country in the world excepting Norway. This development is 0.26 hp. per capita, while that of Norway is 0.54 hp., and of the United States is 0.07 hp. The United States, with 30,000,000 hp. available, leads the world in potential and developed water-power resources, Canada ranking second.

The accompanying chart, which was prepared by the Canadian Commission of Conservation, presents a concrete picture of Canada's "white coal" resources and their development. In general, Canadian water powers are applied to three uses: (a) municipal purposes, (b) for manufacture of pulp and paper, and (c) for electrochemical and similar processes. Of the developed water power about 78% is used for municipal purposes, about 14% for the pulp and paper business, and about 8% for electrochemical or similar processes.


MERIDIAN DISTRICT
CENTRAL ELECTRIC STATIONS
Hydraulic (h.p.)
Steam (h.p.)
Internal Combustion
TOTAL WATER-POWER (h.p.)
60 – 65 1,486 23,502 777 620,800
65 – 70 13,348 15,131 1,298 942,200
70 – 75 598,463 36,325 253 3,690,000
75 – 80 685,581 57,934 228 4,820,000
80 – 85 112,183 8,135 8,187 1,640,000
85 – 90 36,008 0 0 250,000
90 – 95 11,800 238 6 1,227,000
95 – 100 78,330 23,168 0 1,745,500
100 – 105 0 9,579 4,101 228,800
105 – 110 0 17,278 1,531 83,000
110 – 115 31,980 58,838 1,332 406,000
115 – 120 48,834 5,683 1,525 844,000
120 – 125 182,620 32,040 755 1,185,000
125 – Int Bdy 37,675 10,061 0 1,135,000
Total 1,836,618 298,202 12,923 18,832,000
The diagrams show the aggregate capacity of the central station plants in the various areas, each of which includes five degrees of longitude. Thus, the most easterly indicates the capacity of such plants in Canada between long. 60°W and 65°W.; the second the capacity of plants between long. 65°W. and 70°W. etc.
They also show the total water-power developed and undeveloped in same areas
The diagrams showing developed water-power indicate the great importance of St Maurice, St Lawrence and Niagara Powers
It should be noted that the figures in the "Total Water-Power" column in this diagram, are the estimated amounts of 24-hour low-water power, and that these amounts can be much increased, the increase depending upon the amount of artificial storage available, the economic head that may be developed and the nature of the industries utilising the power
Total Water-Power, developed and undeveloped
Hydraulic Plants, Capacity
Steam and Internal Combustion Plants, Capacity
Vertical Scale, 1 inch = 1,000,000 h.p
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
BRITISH COLUMBIA
ALBERTA
Edmonton
Calgary
SASKATCHEWAN
Regina
MANITOBA
Winnipeg
HUDSON BAY
ONTARIO
QUEBEC
Vancouver
Victoria
Toronto
Montreal
Quebec
Note
The above diagrams include the water-power between long 125° and the boundary between Canada and Alaska
125 120 115 110 105 100 95 90 85 80 75 70 65 60

Central Stations and Total Water-Power Resources in Canada.

Integrating Wattmeter Accuracy and Testing Practice

Setting of Permanent Magnets an Important Factor in Accuracy—Dust Influences Meter Action — Bearings and Lubrication Need Attention—Accuracy Specified in Rules, Ordinances and Statutes

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All companies furnishing electric service for general distribution are dependent upon electric watt-hour meters for the measuring of the power consumed, from which the amount due to the company is calculated. Considering the importance of the meter with regard to the financial interest of the company it receives a minimum of attention and care, and if every periodic reading is higher than the previous one the meter is generally considered to be correct. This condition is found more often among the small municipal plants and the small towns supplied by the transmission lines than on the larger systems. Many states and the principal cities have enacted laws or ordinances governing the testing of watt-hour meters, and the allowable variation in accuracy is definitely specified. A summary of such laws and ordinances is shown in an accompanying table which shows a variation in the allowable accuracy from 2% to as high as 4%. All manufacturers test and adjust their meters before shipment to within the limits of 2% error, either fast or slow, on any load condition suitable for that meter.

MAXIMUM WATT-HOUR-METER ERRORS ALLOWED BY COMMISSION REGULATION.

State.	Allowable error.
Arizona	3% on light load, half load or full load.
	2% average error.
Connecticut	2% at heavy load.
	4% at light load.
	4% on commission test.
District of Columbia	4%.
Illinois	4% average error.
Indiana	4% on light, half or full load.
	4% on commission test.
Maryland	1% adjustment.
	2% in service.
Missouri	1% of correct registration.
Montana	4% between one-tenth and full load.
Nevada	2% on normal load.
	3% on one-tenth rated meter capacity.
New Hampshire	4% on light, normal or heavy load.
New Jersey	4% on light load or heavy load.
Oregon	4%.
Pennsylvania	4% average on light and heavy load.
Washington	1% on one-tenth or full load.
West Virginia	2% on light load or heavy load.
Wisconsin	4% between one-tenth and full connected load.

A summary of meter accuracy showing that watt-hour meters do need attention, and that the central-station company is benefited by the testing is shown in an accompanying table. A correct meter not only keeps the good will of the customer but increases the revenue of the operating company, and to maintain a high standard of accuracy it is necessary that all meters be tested either previous to installation or immediately thereafter and at regular periods of time as long as the meter remains in service. With single-phase a-c. meters, such as are generally used for residence and commercial lighting, the schedule for periodic testing recommended requires that meters of a rated capacity exceeding 25 amperes be tested at least once every 24 months, and meters of 25 amperes and less be tested every 36 months or less.

From the results shown in the accompanying table it is readily seen that meters should receive attention and periodic testing while in service. It is necessary therefore to understand the simple mechanical and electrical construction of the meter and the reasons for failure to register correctly, together with the method of testing and adjustment.

Essential Parts and Operation of Induction-Type Meters.

The essential parts of the induction-type watt-hour meter are the stationary element comprising the electric and magnetic circuits, the rotating element, a registering mechanism and the retarding magnet. The electric circuit is divided into two separate parts, one consisting of a coil made up of a large number of turns of fine wire connected across the circuit. The other part consists of two small coils of heavier wire connected in series with each other and in series with one of the wires of the circuit. These two sets of coils are wound on a laminated soft-iron core of irregular shape, depending upon the make of the meter, which serves as a path for the magnetic lines of force set up by the action of the coils.

MAXIMUM WATT-HOUR-METER ERRORS ALLOWED BY STATUTE.

State.	Allowable error in per cent.
Arizona	3
Connecticut	4
District of Columbia	4
Maryland	4
Massachusetts	5
Missouri	4
New York	4
North Carolina	2½
Rhode Island	2
Washington	4
West Virginia	2

The rotating element consists of an aluminum disc or ring mounted on a light spindle and supported by some form of as near a frictionless bearing as it is possible to design. Only two different forms for the lower bearing are now in general use—the pivot bearing and the ball bear-

ing. The upper bearing is of the pin type, consisting either of a small steel pin extending from a brass screw into a recess drilled in the upper end of the spindle, or the bearing is reversed having the pin a part of the spindle and fitting into a hole drilled into a brass screw mounted above the upper end of the spindle. This bearing is lubricated by the placing of several discs of billiard cloth saturated in clock oil in the bottom of the recess in the upper end of the spindle with which the end of the pin comes in contact.

Two Types of Bearings in Common Use.

The pivot bearing consists of a small cup-shaped jewel mounted in a suitable fitting which is supported by the frame of the meter. The end of the spindle has a special fitted point which rests in the cup jewel. A ball bearing consists of a lower jewel similar to that used with the pivot bearing and a similar cup-shaped jewel fitted to the lower end of the spindle. A small steel ball is placed between the two jewels. The friction of the two types is nearly equal. Sapphire has been extensively used for jewels, but recently diamond has been used and shows better wearing qualities together with less friction than the sapphire jewel. This bearing should be cleaned and oiled with high-grade clock oil whenever the meter is given its periodic test. The registering mechanism consists of a reduction-gear train which reduces the speed of the disc to that of the first registering dial, the dial train, and the dials. The parts of the mechanism are usually made of hard brass and are gold plated to prevent corrosion.

MAXIMUM WATT-HOUR-METER ERRORS ALLOWED BY CITY ORDINANCES.

City.	Allowable error in per cent.
Charleston, S. C.	4
Chicago, Ill.	4
Cincinnati, O.	5
Kansas City, Mo.	2½
Louisville, Ky.	4
Minneapolis, Minn.	2½
Memphis, Tenn.	3
Norfolk, Va.	4
Sandusky, O.	3
San Francisco, Cal.	2
Sioux City, Ia.	2
Topeka, Kan.	3

The permanent magnets—one in some meters and two in others—are mounted so that their position may be adjusted relative to the position of the aluminum disc, thus increasing or decreasing the retarding effect by changing the value of K or ϕ in the equation

$$T = K\phi^2$$

where T is the retarding torque on the disc or ring, K is the speed of the disc or ring through the magnetic field, and ϕ is the strength of the magnetic field. It is evident that a small change in the value of ϕ will be an important factor in changing the retarding effect and, indirectly, the accuracy of the meter. For this reason the manufacturers use special care to see that only steel which will retain its magnetism indefinitely is used for the magnets.

All reliable manufacturers make every effort to produce an electric meter which will retain its accuracy indefinitely, but some defects are always liable to occur even after the meter has left the factory. Certain parts of the meter are more liable to be the cause of its failure to register correctly than others, though the cause may be due to the partial or complete failure of any of the essential parts of the meter as previously listed.

Current Coils Not Often Subject to Failure.

Failure in the electrical circuit usually occurs in the potential coil, resulting in the insulation being more or less completely destroyed. Such trouble can be remedied only by placing a new coil in the meter. The failure of the current coils is always possible, but with the circuits properly protected by fuses the circuit is usually opened whenever there is an overload before any material damage is done to the meter. Care should be taken to see that all terminals and contact screws are tight before the meter is installed.

The meter case is intended to be dustproof, but on examination of many meters which have been in service where they have been exposed to unfavorable conditions there is usually more or less dust collected inside of the meter. This is especially true in meters where it is necessary to remove the main cover to connect the various wires. Dust on the revolving element results in a change in its weight, and a corresponding increase in the amount of friction, with a loss of accuracy on light loads. Dust in the bearings causes excessive friction and impairs the accuracy accordingly. Cases have been cited where small spiders have spun webs inside of the meters and also where ants have gained an entrance and destroyed the meter completely.

When dust is detected the meter should be cleaned as thoroughly as possible and the bearings oiled. Cleaning and oiling of the bearings is important for the highest accuracy, and every meter should have the bearings cleaned and oiled at the time of the regular periodic test or at intervals not to exceed 36 months. For this purpose a high-grade watch or clock oil should be used, and care must be taken that an excess of oil is not applied. A satisfactory method is to take a piece of cloth absolutely free from lint which has been partially saturated with the oil and wipe the parts of the bearings with this cloth. The wiping will not only remove any particles of dust adhering to them, but will leave a film of oil which will be found sufficient for the lower bearings. A small drop of oil may be put into the upper bearing and will be absorbed by the discs of billiard cloth, but care should be taken that an excess of oil is not applied. It is obvious that the parts must be properly reassembled and tested after oiling.

The registering mechanism is practically free from defects, and if the meter is kept free from dust it will not impair the accuracy of the meter. Any corrosion on the reducing gear would be liable to cause a retarding effect, or to completely stop the meter, and to prevent this the manufacturers give all parts of the gear train and dial train a thin gold plating.

Rough Treatment and Time Influence Magnets.

Only rough treatment will impair the permanent magnets. Magnets may weaken slightly with age or rough handling, but with the material now

used the original magnetism is retained indefinitely. Shop tests previous to installation often find meters in which the magnet has not been properly secured at the factory so that the jarring in shipment has caused it to shift its position enough to cause the meter to register incorrectly.

Meters may be tested by the use of an indicating wattmeter and stop watch, and where more information is desired an indicating ammeter and voltmeter may be used. The indicating wattmeter will show the number of watts actually consumed at the time of reading, and with a steady load and constant voltage on the line the number of watts measured by the integrating wattmeter can be calculated by knowing the meter constant and the number of revolutions of the disc during a given period of time. The meter constant is usually painted on the meter disc, or can be found as a permanent mark elsewhere on the meter. By counting the number of revolutions of the disc during a given time the number of watts may be calculated by the accompanying formula.

$$\text{Watts} = \frac{3600 \times K \times R}{S}$$

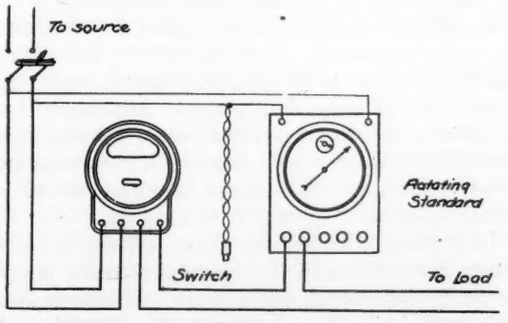
where 3600 = number of seconds in an hour, K = meter constant as marked on the meter, R = number of revolutions counted, and S = number of seconds required for the disc to make R revolutions.

The accuracy of the meter can then be calculated by the formula

$$\%\ \text{accuracy} = \frac{100 \times \text{calculated watts}}{\text{Indicating-wattmeter reading}}$$

ROTATING STANDARD FOR METER TESTING.

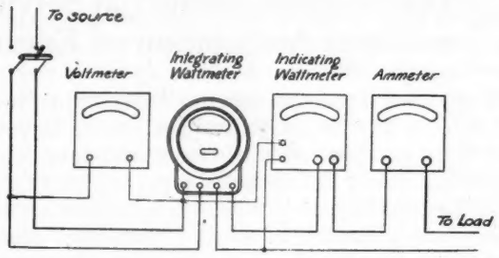
A method much simpler, more flexible and equally as accurate involves the use of the rotating standard testing set. This set consists essentially of a special induction-type wattmeter element with a pointer attached to the disc spindle so that its revolutions may be counted, and by having the pointer revolve over a dial divided into 100 equal divisions so that fractions of revolutions can be accurately read. An external cord and switch are connected to the potential circuit



Connections for Testing Meter With Rotating Standard Set.

of the meter so that the meter may be started and stopped by the operator while at some distance from the meter. This meter possesses the advantage that its registrations are independent of any error due to fluctuating voltage or current during the time of the test.

For testing meters in residences it has been found desirable to have the meter tester equipped with some means of supplying the loading desired independent of the house load. The method of using the customers' load not only destroys the good will of the consumer, but requires too much additional time going over the circuit turning on and off the load as required. The test should be



Connections for Testing Meter With Portable Indicating Instruments.

made covering the following percentages of the rated capactiy of the meter: Full voltage and no current—creepage test; 2% rated current—to test for smooth and continuous running of the meter disc; 10% rated current; 20% rated current; 50% rated current; 100% rated current, and 150% rated current.

Test at 20, 50 and 150% rated current may be omitted, but no meter should be considered tested on which its accuracy at full load and light load is not definitely known. As creepage is one of the most common complaints of customers, the meter tester should be required to definitely check this test. A meter is considered as creeping when the disc makes one complete revolution in 5 min. or less.

In comparing statistics prepared by the New York Public Service Commission and the National Electric Light Association it is found that the percentage of meter accuracy has been highly improved during recent years. But the meter is at best only a delicate instrument, and should therefore not be neglected since it has such a vital bearing on the financial revenue of the operating company.

SITUATION IN GERMAN ELECTRICAL INDUSTRY.

A director of the Siemens-Schukert, one of Germany's large electrical engineering and construction firms, recently made a survey of the situation in this industry. He states that in 1920 not more than 30% of the pre-war production of high-tension cables will be turned out in Germany. The situation in the wire, motor and installation industries is also bad; power plants are placing but few orders, apparently being uneasy over the question of socialization. The outlook for business with the street-car companies is discouraging, constant increases in wages having prevented the purchase of any new cars. In 1919 the value of lamps produced amounted to 70,000,000 marks. Before the war 50% of Germany's lamp production was exported, but at present less than 25% is exported. It is said that foreign competition in the lamp trade is much keener than before the war.

Distribution Problems of Central-Station Companies

Suggestions Made on Interconnection of Systems, A-C. vs. D-C. Distribution, Industrial Service and Voltage Regulation by Committee of Association of Edison Electric Illuminating Companies

That there are economies to be derived from the interconnection of central stations is beyond question, as demonstrated from the numerous consolidations of utilities in the past. Practically each large utility as it now exists comprises the systems of a number of smaller companies which have been combined to serve a given territory. In this process some of the inefficient plants have been discontinued, while others have been retained for standby or peak-load operation, thus effecting large economies in operation and investment charges, far outweighing the cost of the additions and changes required to combine the systems involved. In the same manner the interconnection of the larger systems is bound to follow for reasons applicable to each local situation.

While the greatest economies are to be obtained by interconnecting hydroelectric with steam plants, it is important to consider any interconnection which will result in a saving in fuel, as fuel materials which are now consumed can never be replaced; therefore, any effort toward their conservation is of importance to the national welfare.

The results to be accomplished in each instance must vary with local conditions; for example, a hydroelectric company normally purchasing a large volume of energy from steam plants during the normal working hours each day when its hydro capacity is insufficient to meet the requirements of its consumers finds it possible in turn to sell back to the steam-operated plants its entire surplus output generated during light-load periods when water is available. Further, the hydroelectric company is similarly enabled to dispose of a large amount of energy during freshet periods when otherwise water would run to waste, due to the practical inability to provide sufficient storage facilities. It is not infrequent that the amounts of surplus power thus available may have an enormous potential value locally when fuel supplies are costly and difficult to obtain. The economies to be effected by the electrification of our railway systems have been dwelt upon at length by many authorities on the subject, the consensus of opinion being that a saving in fuel alone totaling 120,000,000 tons per year would result from complete electrification, entirely aside from the attainment of other favorable results even more important than fuel saving.

Points of Discussion on Interconnection of Distribution Systems.

Notwithstanding the many papers and reports presented on this subject, there remain many points open for discussion among which are the following:

Can lines of 200,000 volts or more be constructed and operated to furnish reliable and satisfactory service?

Will such lines be as free from lightning disturbances as has been contended?

Will a single-circuit line be satisfactory?

Where transmission distances are of the order of two or three hundred miles, will the amount of energy that can be transmitted over such a line warrant the investment required for its construction and operation?

What means should preferably be provided for controlling the regulation of energy flowing over interconnections where the sending company today may be the receiving company tomorrow? The choice of means at present rests with the use of transformer taps, induction regulators, synchronous condensers, etc.

Should the frequency of an interconnected system be controlled from a single station?

What form of rate schedule and basis of charge should be used between companies for energy transmitted over interconnections? It must usually follow that the larger utilities can sell to the smaller companies at lower rates than the latter can sell to the former. On the other hand, the larger companies are not likely to be interested in the purchase of energy at prices higher than their own costs except in emergencies, when they would probably be ready to pay any price for energy for relief. Upon what basis should the investment required for a given interconnection be contributed by the interested parties?

Should not and cannot all future developments employ a frequency of 60 cycles? It is believed that the answer to this question should be "Yes," since there remains but a single important class of service, viz., the electrification of railway service, which may possibly require some frequency other than 60 cycles in some instances where alternating-current operation is adopted.

In dealing with future electrification developments it is contended that each local utility should be vitally interested, for without question railway service is logically a utility load. Usually railway electrification will contribute materially toward interconnecting various districts in the same manner as the railways serve different communities.

The design of any distribution system developed for railway service should at the outset provide for the use of the railway alternating-current bus for both railway and general distribution pur-

poses where possible, as such design makes unnecessary any duplication of lines over the territory involved. Where possible use should be made of the railway substations for general distribution purposes, thus further facilitating an economical use of plant investment.

Alternating-Current Versus Direct-Current Distribution.

From time to time this question has been the subject of active discussion as regards the most desirable policy to be pursued in further extensions of systems of distribution. It is not unlikely that in many cases the executives of the larger companies look upon the direct-current Edison systems as the cornerstone of the industry, and that any suggestions looking to their abandonment solely for reasons of economy are not received with much enthusiasm. While it is inadvisable to broadly recommend such a course, a definite boundary should be established in all the larger systems beyond which no extensions of the direct-current system shall be made. The entire question may be said to rest on the success with which alternating current may be used in place of direct current for general use.

In certain locations the answer has been found, since in one of the larger systems the boundary of the direct-current territory has been moved twice within five years, the present area inclosed by this boundary being only 22% of the area originally served by direct-current service. In this particular system alternating-current service is supplied in certain portions of the direct-current district for loads in excess of 45 kw. on five-year contracts embodying special conditions. In another of the systems 15% of the area of the direct-current territory supplies 85% of the low-tension direct-current load. It is obvious that the boundary in this case should be drawn to include but 15% of the present direct-current area.

It must be admitted in advance that a low-tension direct-current system is inherently better adapted for general use and when properly installed and supplemented with storage-battery reserves affords a larger measure of insurance for continuous service than is possible with any alternating-current system.

It must further be admitted that alternating-current service is not well adapted to certain processes such as high-speed elevator service, variable-speed tools, etc., although the advances in the art are rapidly overcoming many of the difficulties previously experienced with such devices. Recently a representative of one of the largest elevator manufacturers expressed confidence in the ability to produce satisfactory alternating-current elevator equipments to operate at speeds up to 400 ft. per min. for approximately the same price as for direct-current equipments. This appears to be the maximum speed attainable at present to compare with 700 ft. obtained with direct-current machines, yet with new developments continually appearing it may only be a question of time when the difference in favor of the direct-current system may be eliminated and the systems rest on an equivalent basis.

Recent practice has indicated the desirability of using motor-generator sets in connection with battery charging, electrolytic processes, moving-picture machines, variable speed tools, etc.; in general, it is confidently asserted that more than 80% of the utility loads are served directly by alternating-current service.

Finally, it cannot be denied that the investment and operating costs for a given direct-current system with the customary storage-battery reserves is far in excess of an alternating-current system of equivalent capacity; therefore, customers using alternating-current service and buying from a company selling both forms of service at the same rates may fairly contend that they are in fact bearing a part of the expense of maintaining and protecting the direct-current system. Under such conditions it is questionable if many customers would pay the added cost of 100% service if they had a choice in the matter.

Industrial Service.

In an effort to increase the continuity of service for certain consumers using alternating current, duplicate services are frequently provided or demanded as the case may be. In some instances the nature of the business or compliance with municipal or legal requirements may require that duplicate service be provided, yet even in such cases it is felt that the customer should bear the added expense for such service, as rates in general do not warrant the additional expenditure on the part of the utility. Central-station companies on every hand are using every effort to make their service as nearly perfect through duplication of supply to substations over different routes, the maintenance of duplicate equipment and elaborate protective devices at known critical points, and the use of the highest class of equipment in all construction, thus effecting as large a measure of insurance against failure as may reasonably be required.

Comment is made from time to time on the unprofitable nature of certain businesses which are offered for connection to central-station lines. There should be no such thing as an unprofitable load if rate schedules are properly constructed to meet all conditions. It is contended that a utility should devise ways and means to supply service as required for any reasonable use wtihout question, and that it should be merely a commercial problem to develop a rate suitable for each condition.

There are without question many instances where certain types of service now classed as profitable could be made more so had the consumer been induced to install a proper type of apparatus, and it is in this direction that the commercial salesman of both utility and manufacturing interests can render valuable assistance in educating the customer to purchase the proper apparatus when he becomes a prospect for electric service. This particular factor is of considerable moment in controlling the power-factor of the system load, as many instances of low power-factor are directly traceable to the use of improper equipment.

Among the newer industries now under development in this country is the fixation of atmospheric nitrogen, a process which has been extensively exploited in Europe where cheap power has been available. An initial installation of a 500-kw. plant is now under consideration in one of our larger cities, the success of which will undoubtedly result in the extension of this industry in many other locations where power conditions are favorable.

Off-peak industrial loads offer opportunities for the expansion of the central-station business through increase in output without requiring increase in generating plant. Further experience with this class of service, where the utility selects the hours of delivery of energy to consumers, indicates that not only is the business in itself profitable at suitable rates but that through a marked improvement in load-factor, and, therefore, an increase in output, the cost of furnishing the balance of the system output is favorably affected.

One of the central-station companies has a schedule in operation under which it sells "secondary service," which permits it to change without notice the hours over which the customer may operate. The following paragraphs are extracted from what is designated as the "miscellaneous energy rate" in that schedule:

"Electricity for certain miscellaneous energy purposes will be sold, under the following schedule, to any customer who has signed an agreement for electric service embodying the terms and conditions of the company.

"'Miscellaneous energy purposes' covered by this schedule are cooking, direct heating, refrigeration by compression, charging storage batteries, electroplating and electrolytic work, water supply and irrigation, and secondary service. 'Secondary service' is service where the customer has sources of hydroelectric, steam or other supply which during the year operate at capacity sufficient to supply the customer's maximum demand and at least a number of kilowatt-hours equivalent to a minimum of two hundred times the customer's maximum demand, or at least 10,000,000 kw-hrs. *and where also the service is supplied solely at the convenience of the company as supplementary or secondary supply,* and the customer provides at his own expense such time switches, circuit-breakers or other apparatus as in the judgment of the company are necessary to protect it against the use of the service other than at times convenient for the company.

"The 'convenience of the company' does not include use during so-called 'peak hours,' but if in any year conditions are such that service can be supplied by the company during *certain peak hours to be specified from time to time by the company,* such service will be supplied to customers applying for the same; such customer may on one week's written notice decrease the number of kilowatts previously applied for, and may at any time apply for an increased number of kilowatts which will be supplied if the company has the available capacity."

At the present time the excessive cost of fuel makes this form of service particularly attractive to the isolated plant owner, yet under practically any conditions it should be possible to secure this business for at least a portion of each year outside of the heating season with profitable results to all concerned.

Metering Practice for High-Tension Service.

Attention is directed to the wide differences in metering practice as applied to industrial service when served from high-tension lines. It is noted that in some instances the utility makes every effort to sell energy direct to the consumer at "high tension," the consumer providing and maintaining all converting equipment. Under other conditions energy is metered and sold at the low-tension terminals of the converting equipment, the utility providing and maintaining the necessary converting apparatus. In the latter case the rates charged for service are higher than in the first case. These two methods seem perfectly logical and reasonable in the interests of both utility and consumer.

Variations from these methods are noted where the utility *prefers* to sell all energy at low tension, owning and maintaining all converting equipment by preference, or instances are noted where the reverse is the practice. Under both conditions, however, the energy is metered on the low-tension side of the equipment serving the consumer, the losses in the equipment being estimated and added to the meter registration to determine the proper input upon which to base charges for high-tension service when sold on that basis. It is obvious that a wider tolerance in meter accuracy must be accepted in such cases than would ordinarily be considered good practice.

A discussion of the reasons governing such differences in practice would be instructive. In one case the utilities' responsibilities terminate with the operation and maintenance of its distribution system, with a marked reduction in spare equipment required to be carried for repairs. On the other hand a utility preferring to provide and maintain all converting apparatus on customers' premises must of necessity carry a larger stock of supplies and maintain a larger operating organization with attending higher costs, particularly in systems serving an extensive area.

Wider Variations in Voltage Regulation Permissible.

It has been a tradition in the history of the industry that close regulation was necessary for the maintenance and supply of satisfactory electric service. While this was undoubtedly true in the earlier days with the apparatus and facilities then available, it is no longer necessary to adhere to the then commonly accepted standard of "2% regulation." It has now been repeatedly demonstrated that materially wider variations in pressure up to 4 or 5% are permissible without causing comment or unfavorably affecting the service supplied in many industries.

In the case of certain appliances in common use it is, however, imperative that a critical minimum voltage be maintained at all times, otherwise unsatisfactory service will result, this factor placing a limit on permissible downward variations in voltage in some instances. Observation of conditions in many industrial installations indicates the possibility of even exceeding 5% regulation at times without comment. Consideration of this subject may result in devising means of making substantial reductions in the investment required for distribution purposes.

EDITORIAL COMMENT

Use of Pulverized Coal Making Steady Progress

Many notable achievements were made during the war, to go unnoticed because of more pressing matters calling for attention. One by one these come to the fore, and then they receive their quota of comment and favorable award. The use of coal in pulverized form as fuel is one of the developments that has progressed in a modest manner but with plenty of success.

It still can be truthfully said that pulverized coal is used mainly in the metallurgical and the cement industries and but little for steam raising. But it can no longer be said that the only power plants using pulverized coal are a few small plants in two or three places. Pulverized coal has made comparatively rapid progress when the high cost of labor and materials and the hesitancy to make investments in equipment on the part of public utilities are all taken into consideration.

Pulverized coal comes to the fore at this time especially because Henry Ford is employing it to heat eight 2647-hp. boilers now being installed at the River Rouge plant. Pulverized coal and blast-furnace gas will be used together under these boilers, ratings of 250% being maintained during the day and 400% when necessary. The Milwaukee Electric Railway & Light Co. has been using pulverized coal for more than a year under five 468-hp. boilers with good success. This company has now about ready for service another station that will burn pulverized coal exclusively under eight 1306-hp. boilers. The station will be the largest yet built where pulverized coal will be burned exclusively. The River Rouge plant has double the boiler capacity, but blast-furnace gas is being used simultaneously with coal.

It has been claimed that pulverized coal is not feasible in power plants of less than 2400 hp. because the investment is comparatively high and the higher maintained economy does not permit the investment to be profitable. Changing prices may alter this situation. The statement is a generality, and, like all generalities, is only a half-truth. Meanwhile in Seattle, pulverized coal is being used in much the same way that fuel oil is used. Coal is pulverized at a central plant and from there distributed in tanks in the same manner oil is distributed to consumers. The consumer of pulverized coal buys his fuel already for use and burns it much as the user of fuel oil does. The plants doing this are not large; they are small, a fact which suggests that perhaps after all pulverized coal is not limited to plants of more than 2400 hp.

The use of pulverized coal will come from evolution and not revolution, meaning that its adoption will be gradual. There is ample opportunity for it, and a pressing need. The power plant at the mine mouth could make good use of the high-ash and high-sulphur coals that are costly to transport, difficult to sell and costly to burn on grates if they were pulverized. There is many a culm bank now a nuisance that would change to a veritable gold mine were a pulverized-coal burning plant installed nearby. These are coming, of course, because they appear inevitable, but the day should be hastened.

Water-Power Developments

After years of uncertainty, indecision and omission, the federal government was finally prevailed upon to pass the water-power act, which created a power commission, composed of the secretaries of war, interior and agriculture, in whom is delegated the power to issue licenses for works for developing water power on public domain, in national forests and on navigable rivers for periods not exceeding 50 years.

Within one month of the passage of this law applications for licenses to develop more than half a million horsepower had been made. This pace has not, of course, been maintained, but there is every indication that the promulgation of a workable water-power policy will eliminate the chief cause of the indifference and inactivity existing of recent years in hydroelectric developments. High costs, scarcity of labor and materials have been other reasons.

Much water is going to waste on lands controlled by the different states to which the federal water-power act does not apply but which come under state legislation. Blame for not developing these cannot be placed upon lack of a workable water-power policy. Higher fuel prices and gradually decreasing costs of goods and workers should encourage such development. The war proved the value of co-operation and the expediency of interconnection of utilities, through transmission lines. Many of the smaller

hydraulic power sites would be feasible if tied in together where each alone would cost too much to develop, might lack sufficient load, and fail to deliver power except during certain seasons. Linking up such power sites helps equalize matters and co-ordinates water flow with load demand.

The automatic station has already proven itself in industrial plant and hydroelectric generating station. In many small water-power developments wages for attendance prohibit the profitable installation of a plant. Automatic control makes such plants possible and profitable. As a further step toward enabling the very small water power to be put to use the employment of outdoor apparatus instead of expensive buildings, etc., has been provided for. These things certainly bring nearer the day of the hydroelectric plant or 100 hp. or so.

The point we wish to bring out here, however, is that there are vastly more small water-power sites awaiting harnessing than there are larger ones. In the past these small resources have been neglected because the larger and more spectacular developments attracted most of the attention. It is sincerely hoped that high fuel costs and the veering of attention toward water-power development in general will combine to turn the floodlights of public interest and professional approval upon the worthy little falls that could, if developed, light up the streets and supply the work shops of many small towns.

Electrifying Railroad Terminals

Central-station companies have always taken a keen interest in railroad electrification. It would, as a matter of course, fall to many of them to supply energy to the railroads rather than for the railroads to build their own power plants.

The enormous coal saving that would come about by the supply of central-station service to the electrified railroad, because of the diversity factor of the railroad load, has been well brought out at different times, notably at Chicago during the National Electric Light Association convention several years ago, and more recently in connection with the electrification and linking up of the New England states. Unfortunately the initial cost of railroad electrification is so enormous that notwithstanding the huge fuel saving the prospects for complete electrification are not so near at hand but what the average central-station company is merely an interested spectator rather than a sponsor for electrification.

However, the central-station companies should keep in touch with the plans of railroad officials, which together have certain significance. The subject of railroad electrification may mean for the utility something else beside immediate or even prospective load of magnitude. For example, at the joint meeting of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers in New York recently "Steam vs. Electric Locomotives" was the subject matter. Each had its advocates, who presented well-correlated facts in very presentable form.

In the statements of John E. Muhlfeld, who championed the steam locomotive, there is food for thought for the central-station fraternity. He stated that the average freight car is in main-line movement only about 10% of its life. The balance of the time is about as follows: 55% in the hands of the railroads on account of interchanges, yard, loading and unloading track movements, track delays, etc., and 35% in the hands of the shipper and consignee due to loading and unloading reconsignments.

Railroad electrification would, therefore, affect but little the actual time a freight car was in actual useful movement. Electrification of terminals and switching yards would immediately speed up car movement and so increase the carrying capacity of the nation's freight cars. Freight yard and switching termini electrification is often feasible where main line electrification is out of the question.

However, the war proved that it was not the main line but the terminal that was the predominating limitation for many railroads. The freight station is the neck of the bottle because of antiquated methods of loading and unloading. If the delays in these operations could be reduced 50%, then 17% of the life of a freight car would immediately be available for something more useful than awaiting the attention of the consignor or consignee.

The central-station companies can well attack this matter of electrical machinery for handling freight. Electric trucks and tractors, portable conveyors in their divers forms, immersion heaters for expediting the emptying of tank cars, and packing and piling machines are but a few of the devices that the central-station companies can honestly advocate, safe in the knowledge that they will save money for their users and conserve railroad cars by hastening their loading and unloading.

Universal railroad electrification may not be immediately feasible. But there are many phases of railroad service which the central-station companies can and should assist for their own sake, for the sake of the railroads and the whole nation.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

SEPTEMBER ELECTRICAL EXPORTS SHOW INCREASE.

Total Amounts to $7,307,068, an Increase of $1,187,480 Compared With Same Month Last Year—Nine Months' Figure Is $67,669,846.

The exports of electrical goods to foreign countries for September were valued at $7,307,068, compared with $6,119,588 for the corresponding month in 1919, or an increase of $1,187,480. For the nine months ending September, 1920, the total exports amounted to $67,669,846, a decrease of $769,358 from the 1919 figures and an increase of $23,912,130 over the total for the nine months ending September, 1918.

The following classified figures give the detailed data for September, 1920, compared with the corresponding month last year:

Electrical machinery and appliances (except locomotives):	Sept., 1919.	Sept., 1920.
Batteries	$ 442,588	$ 607,936
Carbons	72,816	119,233
Dynamos and generators	525,040	461,673
Fans	49,768	70,489
Heating and cooking apparatus	91,881	95,986
Insulated wire and cables	301,315	635,641
Interior wiring supplies, including fixtures	146,729	241,042
Lamps—		
Arc	374	1,053
Incandescent—		
Carbon filament	10,861	4,402
Metal filament	358,396	244,047
Magnetos, spark plugs, etc	226,843	271,177
Meters and measuring instruments	208,496	190,331
Motors	733,891	1,230,408
Rheostats and controllers	38,326	33,309
Switches and accessories	339,188	281,635
Telegraph apparatus, including wireless	31,262	38,093
Telephones	199,936	246,841
Transformers	153,508	208,493
All other	2,188,370	2,325,279
Total electrical machinery, etc.	$6,119,588	$7,307,068

METROPOLITAN CONTRACTORS HOLD SEMI-ANNUAL MEETING.

Co-operation With Central-Station Companies, Merchandising and Industrial Lighting Are Considered at New York City Convention.

With an attendance of over 300 the semi-annual meeting of the Metropolitan District Association of Electrical Contractors and Dealers was held in the auditorium of the New York Edison Co., New York City, Dec. 8. Among the speakers was Walter Neumiller, New York Edison Co., and M. S. Seelman, Brooklyn Edison Co. The latter spoke on the relations between his company and the electrical contractor-dealers, and emphasized the desire to co-operate fully in rendering service to the ultimate consumer. W. L. Goodwin, General Electric Co., told of the need of educating the contractor-dealers in modern merchandising methods, equipment and installation regulations, and the vital necessity of all those in the electrical industry financially supporting the central-station companies at this time.

Another feature of the meeting was an address on "High Level Industrial Lighting" by A. S. Turner, Edison Lamp Works of General Electric Co. Good and bad lighting effects were demonstrated, and the benefit that a properly informed electrical contractor could bring to an industrial customer by recommending and installing the correct illumination system was clearly shown.

A. I. E. E. TO DISCUSS RUBBER-MILL ELECTRIFICATION.

On Jan. 14 the American Institute of Electrical Engineers will hold its 366th meeting in Cleveland and Akron, O. At the latter place the plant of the Goodrich Rubber Co. will be inspected and the members will then be taken by special cars to Cleveland in time for dinner, after which there will be a technical session. The general subject of the technical session will be "Rubber Mill Electrification," and several papers on different phases of it will be presented under the auspices of the industrial power commission. Announcement has been made that the midwinter convention will be held Feb. 16-18, a week earlier than originally planned.

FINANCING AND SERVICE DISCUSSED BY ILLINOIS ASSOCIATION.

Installation and Operation of Rural Lines Studied —Relations with Customers a Vital Factor in Central-Station Industry.

Modification of service rules, rural service, metering, sale of public-utility securities and related subjects were discussed at the convention of the Illinois State Electric Association held Dec. 9 at the La Salle hotel, Chicago. B. J. Denman, president, in his address opening the convention, called attention to various phases of the financial and industrial conditions now prevailing and pointed out the fact that utility securities were again coming into favor. He suggested that it might be well for the central-station industry to take a leading part in some movement to stabilize the coal industry in order to prevent a repetition of conditions that have prevailed during the past two, three or four years. The return of the railroads to approximate pre-war efficiency has done much to reduce the stress of the coal situation for the present, but plans to assure a steady production in the future are essential to the good of the industry as well as to the good of the entire country. Mr. Denman called attention to the fact that money secured through the sale of bonds could not be considered as capital, and stated that some companies were at the present time experiencing difficulty in refunding such investments. The selling of securities to customers has been one of the most

important developments in utility financing during the past two years, and good results are being obtained along this line by many companies.

According to Mr. Denman the central-station industry has been backward in asking for increased service rates, being contented with an average increase of 17% while gas and other utilities have received increases of approximately 40%. He recommended that increases be asked for wherever needed, in order that the utility and its customers be protected from loss and poor service.

Modifications in Service Rules.

An analysis of recent modifications in service rules of the Public Utility Commission of the State of Illinois, presented by L. Owen, Peoria, showed that the modifications were, in the main, changes of language rather than changes in requirements. However, changes were made in certain cases. More comprehensive metering of central-station and substation output is required by the new rules, and watt-hour meter accuracy must be maintained at 3% instead of 4% as previously prescribed. The central-station companies are relieved of testing new meters when they are properly tested at the factory. However, the larger meters must be tested within 60 days after installation and meters rated at from 5 to 25 amperes must be tested within a year. The testing periods have been extended, and customers must be given a copy of the test results if requested in writing. Voltage regulation is limited to 5% above and 4% below standard between sunset and 11:00 p. m., with wider limits allowed for other times during the day. Voltage surveys are required every three years, and scattered checks must be made at various times to assure the maintenance of standard conditions. Grounds are required to be made to water pipes, and more than one ground is required where two or more buildings are served from one transformer. However, discussion following the analysis of the rules developed the fact that other regulations in some localities prohibits the making of ground connections to water pipes. Free overhead service extensions must be made to a distance of 250 ft. per customer or its equivalent, 500 ft. being definitely specified as an equivalent where poles are already in place. Longer extensions can be demanded by the customer in cases where the probable bill for service will justify such extension.

Discussion of the changes in rules indicated that it was the feeling that the new features only added to the already heavy burdens of the central-station companies. Action was taken to continue the work of the rules committee, to the end that further modifications might be made to the mutual advantage of both the customers and the companies.

Problems Involved in Rural-Line Extensions.

The many and difficult problems involved in supplying rural service were covered in a paper by D. W. Snyder, Bloomington. The diversity of opinion as to how such service should be handled was illustrated by the fact that the replies to 600 questionnaires did not show any two identical methods. However, the rulings of the utility commission are shaping certain definite policies to be followed. These rulings allow either the rural customers or the central-station company to finance the extensions required, but title to the lines must rest in the utility company before they can be used. A contract for service must be completed before construction work can be started on rural extensions, and the character of construction, together with the various details, must be approved before authority will be given to build any given line. Charges to all customers on a given line must be the same for equal service, but the actual rates charged must be based on the costs applying to the particular line. The charge per kilowatt-hour must be the same to rural customers as to the city customers of the company, and an added service charge may be made to cover investment, maintenance, operation, etc., applying to the rural line.

Discussion of the paper brought out the fact that various interpretations could be placed on the terms "rural customer" and "industrial customer." F. J. Baker, Chicago, pointed out some of the difficulties that will arise unless specific definitions are formulated to differentiate between a rural-industrial customer and a rural-farmer customer. Further discussion developed the fact that the question of rates must be settled with the utility commission for each extension.

Intensive training of metermen was shown to be of great value in a paper by R. D. Hart, Peoria. His report gave an outline of a two-weeks' course of intensive study and practice carried on at the University of Illinois, in which 59 metermen and instructors participated. Men from 23 companies in the state went through the course, and all were reported to have been greatly pleased with the results. Lectures, laboratory work, discussions and examinations were coordinated to develop and correct points of weakness and to link together the points of theory and practice.

Measurement and Influence of Low Power-Factor.

Measurement of energy at low power-factor was treated in a paper by E. T. Anderson, Moline. The method of measuring power-factor, or the effects of poor power-factor, were shown to be closely related to the form of rates for service, and rates and measuring methods must be adopted to each other. Determination of power-factor by periodic tests with portable meters does not give an accurate basis for charges. The method of using two single-phase wattmeters to measure the total load, and computing the power-factor by the formula

$$\text{Power-factor} = 0.5\sqrt{(1+R^3)/(1+R^3)},$$

was said to give an average power-factor although not the true value when applied to a three-phase load. In this equation R equals W_2/W_1, where W_1 is the larger reading and W_2 is the smaller one.

Graphic power-factor meters are satisfactory where the load is fairly well balanced, and are useful when used in connection with a graphic wattmeter. However, such instruments are expensive and so can be used only in connection with large services. The use of kilovolt-ampere meters is possible, but such devices are expensive and introduce the complication of an added unit,

—the kilovolt-ampere—to be dealt with in billing the customer. The use of a wattmeter, connected to read the reactive component of kilovolt-amperes, in connection with a wattmeter reading the power component was said to offer a feasible solution of the power-factor metering and billing problem. Where it is desired to know the power-factor at a given time meters of the graphic or printing type may be used, and thus a continuous record will be made from which watts, power-factor and the reactive component may be determined for any period.

In a prepared discussion F. S. Douglas, Mattoon, called attention to the fact that increased demand was the most important result of low power-factor. He also stated that the reactive-component meter does not measure directly the effect of different values of power-factor, but only supplies the second leg of the triangle of values from which various calculations may be made. General discussion developed the fact that improvements in power-factor are made where charges are made for the reactive component, or on some other basis. B. H. Peck, St. Louis, stated that rates had been made in one instance in Illinois with a power-factor clause included. D. A. Henry, electrical engineer for the utility commission, stated that no formal rule had as yet been adopted to provide for a general power-factor clause in rate schedules. J. C. Wilms, Chicago, called attention to the fact that volt-ampere-hour meters were in service in the plant of the B. F. Goodrich Rubber Co., Akron, O., but said that these meters were quite expensive.

Customers as Purchasers of Utility Securities.

"Sale of Securities to Customers" was the title of a paper by F. H. Scheel, Chicago. The advantages of the so-called customer-ownership idea were shown as being divided between the company and the customer-owners. The company benefits by a wide distribution of stock, permanent investment and satisfied customers. The customer-owner benefits by the holding of revenue-paying securities and by helping the utility company to supply good service of which he receives a portion. The enlisting of employes as salesmen gives them a new feeling of interest in the company, and the public seems to have a feeling of confidence in these men and the securities which they offer to their friends and neighbors that is lacking in professional salesmen.

In discussing this paper T. A. Schlink, Peoria, told of the experiences of his company in marketing $300,000 worth of stock to customers. The work in Peoria was quite successful, the customers of the company evidently being pleased to have an opportunity to make conservative investments in local properties.

In a forceful talk on publicity M. H. Aylesworth, executive manager of the National Electric Light Association, pointed out the fact that the problem of the utility company is the problem of the public. Neither can take advantage of the other without detriment in the end to both. The various utility commissions represent the interests of the public, and the problems of the companies should be placed fairly and fully before the commissions in order to lay the foundations of sound and satisfactory regulation. He pointed out the fact that the utility business was a continuous one, and that an indeterminate franchise under state supervision offered the only sound foundation for such an enterprise. Commission regulation has done much for the utilities, but, Mr. Aylesworth stated, the courts would probably have given them more consideration. This is a proposition which has been overlooked by those who are endeavoring to secure reductions in rate by "home-rule."

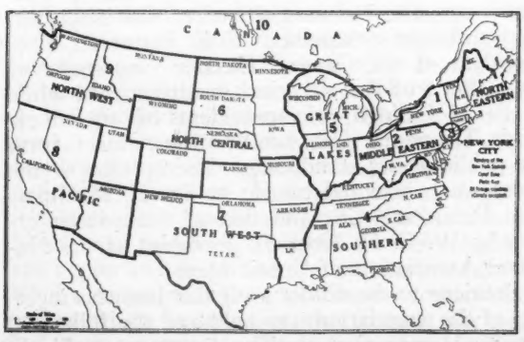
In order to instruct the public, information must be presented in such a manner that the public will like to read it. Technical information and discussions are of no public interest and will not be given consideration, while interesting facts of less technical value will often be received with keen interest.

At the noon luncheon, served in the convention room, Martin J. Insull, president of the National Electric Light Association; B. J. Mulaney, chairman of the Illinois Committee on Public Information; John F. Gilchrist, vice-president, Commonwealth Edison Co., and C. A. Munroe, vice-president, Commonwealth Edison Co., Chicago, gave short pointed talks on the value of publicity. Information that teaches the average man the value of utility service should be presented as often and in as many ways as possible, and repetition of the basic facts will serve ultimately to impress upon the public the importance of the utility company and its prosperity to the prosperity of the community and the individual.

Officers elected for the coming year are Adam Gschwindt, Rockford, president; D. E. Parsons, East St. Louis, vice-president, and R. V. Prather, Springfield, secretary and treasurer. Action was taken during the meeting towards affiliation with the National Electric Light Association under the new organization plan.

TO ELECT A. I. E. E. VICE-PRESIDENTS BY DISTRICTS.

The directors of the American Institute of Electrical Engineers at a recent meeting adopted certain revisions of the by-laws, including the definition of the ten geographical districts decided upon by the committee on geographical divisions and election procedure. As provided in the by-laws, candidates may now be proposed for nomination for the offices to be filled at the annual election in May, 1921. The officers to be elected are a president and a treasurer for the term of one year each, ten vice-presidents for the term



Geographical Districts of A. I. E. E. Created for Purpose of Electing Vice-Presidents.

of two years each, and three managers for four years each.

According to the revised constitution one vice-president must be elected from each geographical district, but this does not debar members in one district, if they so wish, from nominating and voting for a candidate in another district. When the votes are counted the candidate for vice-president having the largest vote in each district will be elected to that particular office for that district, irrespective of the fact that he may have polled a smaller number of votes than a man standing second in another district.

PROTESTS RATE ADVANCES MADE BY NEW YORK COMPANIES.

City Corporation Counsel John P. O'Brien of New York City has entered suit in the supreme court on behalf of the municipality in protest of the recent advance in lighting rates to small consumers made by the New York Edison Co., the United Electric Light & Power Co., and the Brooklyn Edison Co. The advance totals about 10% and was made by the utilities on account of the increased cost of coal. An order has been issued by the court restraining the company from collecting the increase until a hearing.

NORTH CENTRAL DIVISION, N. E. L. A., TO MEET IN DULUTH.

At a recent meeting of the executive committee of the North Central Electric Association a geographic division of the National Electric Light Association, it was tentatively decided to hold the next convention at Duluth, Minn., June 14-16. It will be the first time that the association has held a convention in Minnesota outside of the Twin Cities.

ASSOCIATION CELEBRATES TWENTY-FIFTH ANNIVERSARY.

Present Business Situation and Outlook Discussed by Members of New York Electrical Credit Association at Annual Meeting.

The twenty-fifth anniversary of the formation of the New York Electrical Credit Association was celebrated by a dinner attended by 150 members and guests at the Hotel McAlpin, New York City, Dec. 14. After William R. Conklin, treasurer of the American Copper Products Corp., Elizabeth, N. J., had given an account of the history of the association, whose membership now totals 197, the business situation was discussed from different viewpoints. C. E. Patterson, vice-president of the General Electric Co., spoke of the attitude of the electrical manufacturer, while J. S. McCullogh, vice-president of the New York Telephone Co., handled the subject from the public utility standpoint. The opinion of the press was presented by H. A. Lewis, McGraw-Hill Publishing Co., and that of financial interests by W. S. H. Koelsch, president of the National Association of Credit Men.

Previous to the dinner a regular business meeting of the association was held and the following directors were elected: Three-year term, H. P. Litchfield, Western Electric Co.; J. L. Owen, E. B. Latham & Co.; C. A. Kane, Atlantic Insulated Wire & Cable Co. The association changed its usual procedure and decided to leave the election of new officers to an organization meeting of the governing board to be held Dec. 21.

ELECTRIC CLUB OF CHICAGO ELECTS NEW OFFICERS.

At an election held Dec. 14 by the Electric Club of Chicago the following were elected to serve during 1921: W. H. Colman, president; A. G. de Clercq, first vice-president; E. F. Kirkpatrick, second vice-president; E. E. Williams, secretary-treasurer; W. E. Bischoff, trustee, and T. J. Rider and Harold Almert, directors at large. There were two tickets in the field, and spirited campaigns stirred up a great deal of interest and friendly rivalry among the members of the club.

ELECTRICAL CREDIT MEN OBSERVE SILVER ANNIVERSARY.

Trade Acceptances, Credit Insurance and Uniform Trade Terms Among Subjects Discussed at Twenty-fifth Annual Meeting.

The annual convention of the Electrical Credit Association of Chicago, held at the Congress Hotel Dec. 9-10, marked the silver anniversary of that organization. The scope of the association extends from the Great Lakes to the Gulf of Mexico and from Cleveland to Denver, so in order that the name should more thoroughly represent the territory covered it was decided to change it to the "Electrical Credit Association, Central Division." With the further object of standardizing the name, Secretary F. P. Vose was instructed to get in touch with the National Electrical Credit Association and the various local organizations, notify them of the action taken and ask their co-operation in the matter of uniformity in name of the various divisions.

In his report for the executive committee, President H. E. Wilkins recommended that the members adopt the trade acceptance plan in their business. He also suggested that the incoming officers inaugurate a movement to arouse the interest of all executives of member companies in the work of the association.

Benjamin P. George, national board member, reported on the progress of the local associations in New York City, Philadelphia, Boston, Denver, Pacific Coast and other centers. The report of the membership committee, submitted by J. H. Taylor, showed 326 members, or a gain of 15% for the year.

The reports of the territorial chairmen indicated that business had been good until a short time ago, when the demand for electrical goods fell off somewhat, due to unsettled conditions in other lines of endeavor. The consensus of opinion was that the spring would witness a revival in the electrical industry.

Howard A. Lewis, New York City, gave an address on "The Trend of the Times," stating that there were three objectives for the association: first, to increase the membership of the organization so as to make it representative of the

electrical industry; second, to take into the association proprietors and general managers of the businesses represented, and, third, to interest and educate every salesman in the electrical industry regarding the fundamentals of the credit situation.

"Credit Insurance" was outlined by John E. Gregory, New York City, and C. H. Mackintosh, Chicago, gave an address on "Better Letters," in which he advocated the elimination of unnecessary words in business letters.

In his address on "Oriental Trade Representation," F. K. Pinckney, Chicago, stated that there is a big market for electrical goods in China, but only men well equipped with a definite knowledge of the requirements of the market should be appointed to represent American firms in the Far East.

The value of E. C. A. membership was commented on by J. D. Meek, Indianapolis, who urged the members to use the association forms to a greater extent than at present and thus make the organization of more benefit to themselves and the trade generally. A. Lapin Cohen, Detroit, pointed out in his talk on "Uniform Trade Terms" the advantages to be gained by adopting uniform rules governing trade terms.

At Friday morning's session "Trade Acceptance Experiences and Results" were outlined by E. W. Shepard, Western Electric Co., New York City, and a plan for furthering the use of the standard cost accounting system was given by H. C. Mealey, National Lamp Works of General Electric Co. Frank H. Ames, Gulf States Electric Co., New Orleans, La., gave a talk on "Credit Conditions in the Cotton Belt," which was followed by a discussion on C. O. D. refusals.

The election of officers resulted as follows: President, Benjamin P. George, Beardslee Chandelier Manufacturing Co., Chicago; vice-president, Arthur F. Hearl, American Electrical Supply Co., Chicago; secretary-treasurer, Frederic P. Vose, Chicago; assistant secretary-treasurer, Walter S. Vose, Chicago; executive committee, W. S. Long, Westinghouse Electric & Manufacturing Co., Chicago; A. C. Fredbloom, Western Electric Co., Chicago; national board member, Benjamin P. George; Viewpoint representative, H. E. Wilkins, Belden Manufacturing Co., Chicago.

The silver anniversary dinner, held Dec. 9, was addressed by Gen. Charles G. Dawes, who spoke on "Taxation and Reduction of Government Expenses." The head table was graced by eight past presidents of the association. Secretary Vose was presented with a chest of silver to mark the completion of his 25 years of service with the organization.

Silver Anniversary Dinner of Electrical Credit Association, Central Division, Held Dec. 9 at Congress Hotel, Chicago.

HERBERT HOOVER ADDRESSES CHICAGO ENGINEERS.

A dinner attended by representatives of the different engineering societies was given at the Engineers Club, Chicago, Dec. 10, in honor of Herbert Hoover, who recently was elected president of the American Engineering Council, the governing body of the Federated Engineering Societies. Mr. Hoover said that engineers, because of their training in quantitative thought and their detached point of view, are in an advantageous position to bring about co-operation between such economic interests as capital and labor. He outlined the purposes of the Federated Engineering Societies and enlisted the support of Chicago engineers in the movement to solidify those in the profession for purposes of public service.

WAR AREA CONDITIONS DESCRIBED AT A. I. E. E. MEETING

"Industrial Reconstruction in France and Belgium," was the topic discussed by O. F. Allen, International General Electric Co., at the Dec. 17 meeting of the Schenectady (N. Y.) Section of the American Institute of Electrical Engineers. The speaker showed by means of slides the devastation wrought in the occupied territory, with particular reference to the destruction of factories and power stations. He also showed the manner in which the work of reconstruction was begun and described present conditions. Mr. Allen also outlined the high-tension transmission system which is to cover the former war zone and form a network somewhat comparable to the proposed super-power system in this country.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

BANKERS ISSUE REPORT ON POWER-PLANT EXPANSION.

Association Points Out Economy Resulting from Expansion of Electric Power Industry, Which Will Mean Financing on Big Scale.

The inevitable expansion of the electric power industry is discussed by the Investment Bankers' Association of America in a report issued to its members, which also points out the greater economy in the generation and transmission of electric power necessary to meet the increased demand for energy. The report states in part:

"The United States Geological Survey, under the special direction of Congress, is now engaged in a survey of the power resources of the Atlantic seaboard between Boston and Washington, studying the practicability and advantages of a co-ordinated superpower system under a plan which would interconnect existing generating facilities of the great power companies in that region, and in addition provide for the construction of hydroelectric works and steam plants at the coal mines.

"Such a plan in its entirety can be consummated only gradually, but the study is most valuable both in calling attention to the economies of central-station generated electrical power over isolated steam plants and the value of the interconnection of existing plants. Much has been done in this direction by the voluntary interconnection of both hydro and steam plants owned by public service companies, facilitating the distribution of power and affording marked economies and reduction in the amount of capital tied up in separate steam reserves.

"The financing of voluntary co-ordinated superpower systems should prove most interesting. The solidarity of the industry, the certainty of a market and the diversity of uses are all factors of sound security issues; it is inevitable that the electric generating and transmission systems will, like the railroads, combine and recombine in larger systems, creating stronger and sounder enterprises requiring large and constantly increasing amounts of capital. The responsibility of directing the building up of these great industrial institutions into sound corporate structures, soundly financed with adequate provisions for expansion, rests largely upon the investment bankers."

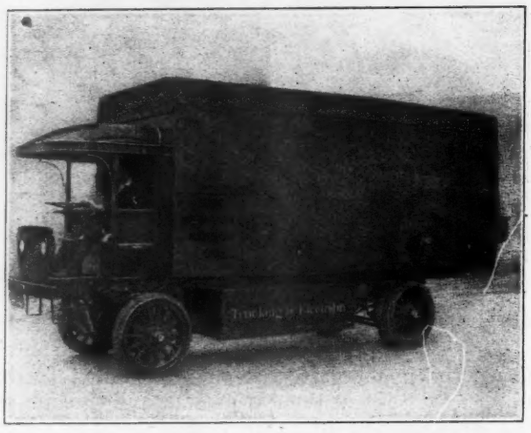
LONG-DISTANCE TRIP MADE BY FIVE-TON ELECTRIC TRUCK.

Feasibility of Long Hauls Proven in Experimental Trip Recently Made by New York Edison Co. Truck.

Maintaining an average speed of better than 12 mi. an hr., a five-ton electric truck made the 96.3-mile trip from Philadelphia to New York City on Oct. 13. The trip was accomplished with only two battery boosts, which indicates new possibilities in long-distance traction for the battery-driven automobile.

The vehicle was built by the Commercial Truck Co. at Philadelphia for the New York Edison Co. The trip from city to city was decided upon, not alone for the sake of a prompt delivery but to make available the operating data for a run of that distance for so large a truck. The start was made at 5:20 a. m. New York time, and at 8:30 p. m. the vehicle was on display at the New York Electrical Show. This makes the elapsed time for the trip 15 hrs. and 10 min. The actual running time was only 8 hrs. The cost of energy for the run was only $4.98, the rate averaging about 6 cents per kw-hr. Battery boosts were given at Trenton and New Brunswick. Thus, the truck made a run of 31.3 mi. on its original charge, a run of 28.9 mi. from Trenton, and a run of 36.1 mi. from New Brunswick to New York City. The Trenton boost of 31 kw-hrs. was given in 250 min. and cost $1.86. The New Brunswick boost of 25 kw-hrs. required 175 min. and cost $1.50.

While the elapsed time of 15 hrs. is not particularly fast, the actual running time of 8 hrs. at a speed of from 8 to 14 mi. an hour is very



Electric Truck Which Made Record Run From Philadelphia to New York City.

good. This includes the time lost on the North River ferry and the time in passing through the 20 or more towns and cities between New York and Philadelphia.

This fast running time and the very low cost of the trip opens up remarkable possibilities for the electric truck as an interurban carrier. Heretofore the electric truck has been considered suitable only for work in the cities and over distances that were within easy reach of the charging station. On the other hand, the gasoline truck has been free to go anywhere where gasoline could be purchased. Then, too, it requires only a few minutes to refill a gasoline tank, as against hours for recharging a storage battery.

If the New York-Philadelphia electric truck run is established, there probably will be two stations where batteries will be exchanged instead of boosted. Thus a truck will run from New York to New Brunswick, change its exhausted battery for a new one, continue to Trenton, where another battery change will be made, and then

finish the trip to Philadelphia. The changing of batteries will be a matter of minutes, and the whole run will occupy between 8 and 9 hrs. Energy will cost less than $5, as compared with the $10 for fuel and oil for a gasoline truck. The fixed and overhead charges will also be considerably less. With such a battery-changing system, trucking by electric vehicles will have all the speed of the gasoline car and all the advantages of economy of the electric.

The truck which made this trip is now in the regular service of the New York Edison Co., hauling such heavy loads as are part of the work of a central-station company serving a large city.

SALE OF PUBLIC UTILITY SECURITIES TO CUSTOMERS.

Customer-Ownership Movement Among Central-Station Companies Outlined in Paper Before Illinois State Electric Association.

By F. H. Scheel

Manager, Investment Department, Commonwealth Edison Co., Public Service Co. of Northern Illinois and Middle West Utilities Co., Chicago.

Customer ownership of utilities has become a tremendous movement. While it has not been recognized generally as it should be, people have, aside from their very definite interest in the service that a utility renders, at all times had a more real interest than has been apparent, whether they know it or not. A growing public realization of this interdependence of the utility and the community is a big factor in the sale of utility securities. Recently it was reported that more than $300,000,000 of the assets of insurance companies is invested in electric light and power securities. It follows that every policy holder or beneficiary is interested financially in the value of these securities. Again, it is reported that there are 27,000,000 depositors in 29,123 banks in this country and that there is invested in public utilities from these concerns an excess of $1,700,000,000 or an average of $63 for each depositor is invested in public utility securities.

Wide Sale of Utility Securities Made in Illinois.

The Illinois Committee on Public Utility Information has given wide publicity to the fact that 275,000 residents of Illinois own public utility securities. These people and their immediate families constitute one-sixth of the population of the state. Next to government bonds public utility securities are more widely owned than any other class of investment in that state. Striking as these figures may seem, the field for sale of utility securities among the people they serve is by no means covered.

The advantages of a wider distribution of securities are so obviously recognized as a means of creating better relations with the public that the fact needs no reiteration. The movement could not have been more timely, following as it does on the footsteps of the vast popular educational work in systematic savings that was accomplished by the liberty loan and war savings stamp drives. And, like these war drives, the sale of securities to utility customers has been found to be essentially a retail problem. It is most successful when regarded as a large merchandising proposition and the model in promoting these sales should not be the investment house but the department store. Many of the established practices of the investment house are only partially effective. The use of the financial circular is essential, of course, in selling to discriminating investors who constitute only a small percentage of the broad customer clientele. Yet how many service customers are really experienced investors?

Merchandising methods are necessary because the appeal is direct to the multitude, and not to any individuals of any well-defined class. John Jones, who owns the corner grocery store, is making money and is an excellent prospect, but he is not an experienced investor. Harry Smith is earning record wages in the steel mills, but it is doubtful that the most dignified and searching report on the financial position of his local utility company would influence him toward stock ownership in that company. It is obvious that in appealing to customers no general knowledge of finance can be assumed. The psychology of the crowd must be studied and the appeal directed to the common sense and common emotions of the people.

If utility companies are obliged to market their securities, advertising must be done with all the skill and wisdom of the great merchants. Many of the circular letter advertising methods of such institutions as the great mail order houses of this country might well be emulated. They have developed this business through long years of successful experience, and their success is evidenced by their present financial standing.

Newspaper and Circular Letter Advertising Calls for Ingenuity.

Advertising should often be seasonable; for example, popular interest in the holiday season is capitalized by Christmas advertisements. Advertising should be planned broadly, too, before launching a stock campaign, so that there is established in the public mind the proper association of ideas in connection with the sale of utility securities. To be most effective, advertisements should be free from finespun argument. It is sufficient that one advertisement should picture to John Jones in an interesting manner his dependence upon electricity in everyday life. Another advertisement might show him how fortunes grow from nickels and dimes and how securities can be bought with nickels and dimes. It is the old story of appealing to elemental human traits.

Publicity work of quite another sort is represented by a small booklet, under the title of "The Tale of Two Hundred Cities," reference being made to the 200 communities served by the Public Service Co. of Northern Illinois. Within is a straight-forward exposition of the interdependence of the communities and the company. Upon inspection it will be seen that the writer, photographer and typesetter have spared no effort to make the booklet easy and pleasant reading. From the reader's standpoint at least it is financial literature only incidentally.

Another booklet, which was prepared for use in a preferred stock sale conducted in the small communities and rural areas of Missouri, makes

an appeal to the local pride of the reader. Most of the numerous illustrations picture the comfortable homes and large public buildings of the towns concerned. The booklet describes the added prosperity that the new transmission line will bring to the community and shows the advantage of ownership in this community betterment.

Another important function of an advertisement is that it is a controlling agency when made the official authorized record of a company's offering. Occasionally the over-anxious salesmen exaggerate, twist statements and make guarantees contrary to the company's policy. This practice, is, of course, harmful to the company, and it can be avoided by making wide circulation of public record of the company's position and its claims for its securities. Thus the conditions of the sale are dictated concisely and effectively from headquarters.

On the formation of a selling organization depends much of the success of a campaign. In all but the smaller communities this medium will be an organization composed of the employes. In each case circumstances will determine the form of this organization.

Employe Salesmen Seem to Get Best Results in Selling Securities.

Nearly all the stock sold by the Insull properties to customers has been sold by regular employes, and it is of interest to know what these selling campaigns in the last 12 months have revealed as the characteristics of the successful employe salesman. It is somewhat of a surprise to some to learn that these men know little of finance and have devoted their entire lives to the operating end of the utility business—not to sales and commercial work, but to trouble shooting, to line work and similar occupations. Just why they are so successful is not clear, but perhaps it is that their long, close association with the company, their absolute faith in its future and their obvious personal probity all combine to win the confidence of the customer.

At this mention of confidence, by the way, it is well to point out that utility companies must realize that in selling securities to the multitude consideration of our customer's interests comes first. It is most certainly a mistake to sell speculative issues to the general public, no matter how potential the possibilities of the particular issue may be. If dividend requirements on the preferred stock issue are earned three times, and the dividends on the common stock are earned only once, it is the preferred that should be offered for sale. It is uninterrupted dividends that customers want, not belated explanations that the common stock is inherently speculative.

Most customers become permanent stockholders, and a reputation for reliability is what must win in the long run. Central-station companies must go forward cautiously in these first experimental days of the customer-ownership idea, realizing that other sales are going to follow the one at hand. The disgruntled stockholder will never buy again. The customer-ownership idea is the logical means of improving public relations.

During the last 12 months of stock selling it is well to note that these new stockholders are not all residents of Chicago. The books of the Middle West Utilities Co. bear the names of stockholders in half the states of the union. Widespread distribution characterizes also the new customer-ownership body of the Public Service Co. of Northern Illinois. This company has acquired stockholders in every one of the 200 communities and cities of every size. This is important because it demonstrates that methods found effective in these organizations are worth consideration.

The utility companies must be retailers of their securities. They must go to the people with the methods of the merchant. But more than that, they must go to them with a high confidence, and an enthusiasm for the industry and their mission. This business of customer-ownership is far more than a problem of financing and corporations; it includes the education of customers, and the reward will be the knowledge that an immeasurable good has been done.

THEFT CASE DECIDED IN FAVOR OF UTILITY COMPANY.

Efforts Made by Dayton Power & Light Co. to Stop Practice of Interfering With Metering of Electric Service Meets With Success.

The legal right of a public utility company to protect itself against consumers who obtain service through fraudulent methods is demonstrated in a decision handed down Nov. 30 by Judge Snediker of the common pleas court of Montgomery county, Ohio. O. B. Reemelin, general superintendent of the Dayton (O.) Power & Light Co., in outlining the action brought against the company, states that the utility has been making strenuous efforts during the past year to stop the practice on the part of some of its customers of tapping ahead of the meter and interfering with the registration of energy. The device used to carry current around the meter is usually called a "jumper." When a case of theft is found, service is immediately disconnected. In addition to this, a number of parties found using devices to defraud the company have been brought into court, indicted by the grand jury and are now awaiting trial.

In one instance, however, where a "jumper" was found and service removed the customer brought mandamus proceedings against the Dayton Power & Light Co. to compel it to restore service. At the hearing and also at the trial the company was able to produce two of its own employes and two city detectives as witnesses to the fact that when they called at the house one evening the electric lamps were in use, the main-line switch was pulled, and the energy was being obtained by a wire around the meter. The plaintiff and his family denied that they had placed the "jumper" on the service; nevertheless the judge immediately handed down a decision denying the prayer of the petition, with a severe reprimand to the customer who had brought the proceedings. The decision is significant, inasmuch as it was given in favor of a light and power company, although there was no witness to testify that he had actually seen the "jumper" installed by the customer. It indicates also that the responsibility rests upon the consumer to see that no "jumpers" are on his service.

OPERATING PRACTICE

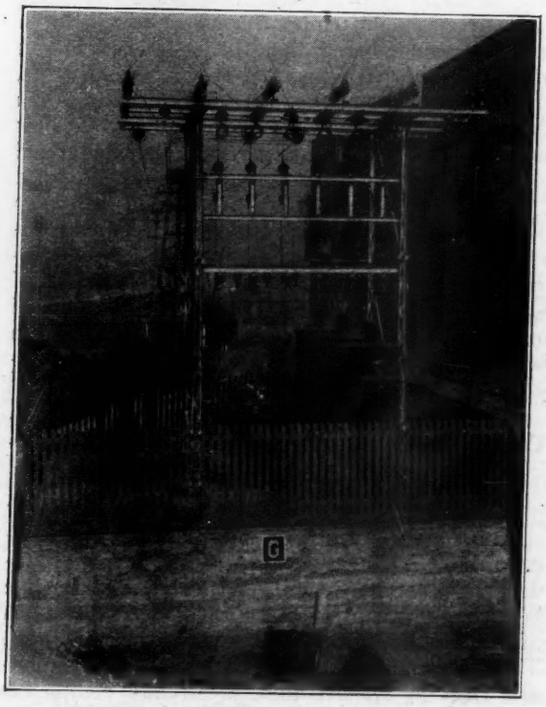
Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

COMBINATION TOWN-LIGHTING AND INDUSTRIAL SUBSTATION.

Two Separate Banks of Transformers Installed in One Structure and Fed by a Common Set of Duplicate Lines.

By H. W. Young,

The Pennsylvania-Ohio Electric Co., Youngstown, O., and the Sharon Pressed Steel Co., Sharon, Pa., have joined in the construction at Wheatland, Pa,. of the joint-ownership outdoor substation shown in the accompanying illustration. There are three 22,000-2300-volt, 667-kv-a.



Outdoor Substation Serving a Town and an Industrial Plant.

transformers installed to supply power for the operation of hydraulic-press pumps in the plant of the steel company. Two additional 100-kv-a. transformers of similar voltage rating and connected in open delta supply power for general lighting and other purposes in the village of Wheatland. Incoming and outgoing lines and various auxiliary devices are connected to and supported by a standard type of outdoor-substation tower.

Service is received from a duplicate 22,000-volt feeder line, each line being controlled by a three-pole air-break switch operated by a handle at the base of the tower. Two additional switches of similar type are mounted on the opposite side of the tower to control the two banks of transformers. The transformer circuits are equipped with long-turn cylindrical choke coils and fuses. The power supplied to the larger bank of transformers is measured by a primary metering equipment mounted on a special platform space. Lightning protection is provided by a set of electrolytic lightning arresters. The unusually high concrete base used in the installation of this equipment was provided to allow for the future filling required to bring this area up to grade. Automatic oil circuit-breakers are installed inside the steel plant to protect the various power circuits. The larger transformers and the lightning arresters were made by the General Electric Co., Schenectady, N. Y., and the smaller transformers were supplied by the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa. The substation tower and switching equipment were supplied by the Delta-Star Electric Co., Chicago.

CHART TO DETERMINE VALUE OF LOW FLUE-GAS TEMPERATURE.

Soot and Scale on Boiler Tubes and Shell Prevent Transfer of Heat and Causes High Stack Temperature.

By W. F. Schaphorst.

To save as much coal as possible, one of the things necessary in the power plant is to maintain the lowest practical temperature in the chimney or waste gases. Hot gases are useful for creating natural draft, but they are very wasteful. It is usually more economical and better to install a mechanical blower for creating forced draft, and exhausting the waste gases into the atmosphere, than to allow those gases to pass away at a temperature of 600 deg. F. or thereabouts. Engineers therefore are advocating the use of temperature recording instruments in the boiler room for keeping a record of the waste-gas temperature. If this temperature runs up to 600 deg. or even 550 deg. F. there is a loss. It is the duty of the engineer to see to it that a low and efficient temperature is maintained.

The best way to maintain low waste-gas temperatures is to keep the boiler tubes clean both inside and out, keeping the soot deposits off the outside and the scale deposits off the inside. By doing this the tubes are enabled to transmit heat easily, and the temperature of the gas will approach the temperature of the water in the boilers. It is impossible, to be sure, to maintain a lower temperature of waste gas than the temperature of the steam being generated without the additional use of an economizer, a mechanical-draft equipment, or some kind of interchange system. The day will doubtless come when in large power plants the waste-gas tem-

perature will be very close to the initial temperature of the feed water.

If the combustion of coal were a perfect process this chimney loss would not be so serious a matter. However, combustion is invariably imperfect. It would be advantageous if we could get along with the amount of air theoretically required, but this cannot be done. In order that combustion may be complete it is the universal custom to supply more air than the theoretical amount required. One authority states that "30 to 50% above that theoretically required, or 16 to 18 lbs. of air per lb. of fuel, is necessary to insure perfect combustion, but in only a very few plants is the air supply maintained at this point. It is often found to run

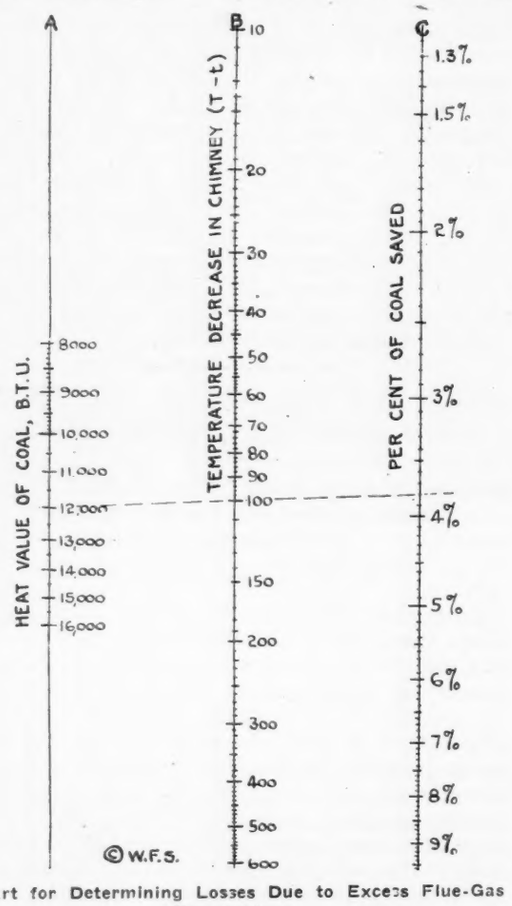


Chart for Determining Losses Due to Excess Flue-Gas Temperature.

from 100 to 200 or 400% excess, entailing great loss of heat in the hot chimney gases."

To avoid extremes it will be assumed that in the carefully fired plants 18 lbs. of air is used per pound of coal fired. Since most of the pound of coal is itself converted into gas there is an extra pound to contend with, or a total of 19 lbs. of burned gases passing out of the chimney per pound of coal fired. The specific heat of this gas is usually taken as 0.24. That is, 0.24 B.t.u. is required to raise the temperature of 1 lb. of the gas 1 deg. F. So, multiplying by 19, we get 4.56 B.t.u. Multiply this by the "excess" temperature that is being permitted—"excess" temperature is the actual temperature of the waste gases before the tubes are cleaned, minus the actual temperature after the cleaning, or $(T - t)$. Thus if the temperature before cleaning is 600 deg. F., and after cleaning it is 500 deg. F., the difference or excess is 100 deg. F. Multiplying 4.56 by 100 we get 456 heat units lost per pound of coal fired. Lastly, divide this by the heat value of the coal per pound. Thus if the heat value of the coal is 12,000 B.t.u., we get $456 \div 12{,}000 = 0.038$. In other words, the loss is 3.8%.

To assist in performing the above mathematical operation quickly, the accompanying chart has been prepared. It is based on the cited figure—18 lbs. of air per pound of coal—which is necessary to insure thorough combustion. By simply laying a straightedge across the chart connecting the heat value of the coal (column A) with the temperature decrease $(T - t)$, shown in column B, the intersection of the extended line with column C gives the coal saving in percent. The dotted line drawn across this chart shows how the problem solved above is worked out by means of the chart. Column C, it will be noted, gives the answer as 3.8%.

The range of the chart is great enough to cover any ordinary power-plant condition, any coal, and any probable temperature decrease. But it must be remembered that the chart is laid out on a conservative basis, and that in most plants, and probably all plants, the loss is greater than shown by the answer obtained in column C. This assumption is based on the fact that in actual practice a greater excess of air is used than 50%.

A permanently installed soot cleaner will keep the outside of the tubes clean at all times, provided, of course, the engineer takes enough interest in his plant to operate it. The effect of scale removal is the same as the effect produced by cleaning off the soot. It gives the heat a better path through the boiler shell, thus lowering the temperature of the waste gases.

COMBINATION OVERHEAD AND UNDERGROUND FEEDER LINE.

A new line being extended from the Northwest station of the Commonwealth Edison Co., Chicago, built partly of overhead and partly of underground construction, will connect to a line between the Evanston and Park Ridge substations of the Public Service Co. of Northern Illinois. The overhead portion of the line, built as standard class A construction, is already completed. The line is carried on wood poles and has an overhead ground wire, 4/0 copper wire being used for the working conductors. Three switches are installed at the junction of the lines to possibly the various desired connections of the circuits. Lightning arresters will be installed at this junction point for the protection of the switching equipment and lines. The underground portion of the line, extending from the generating station to Devon and Crawford avenues, will be constructed of 500,000 cir. mil cable.

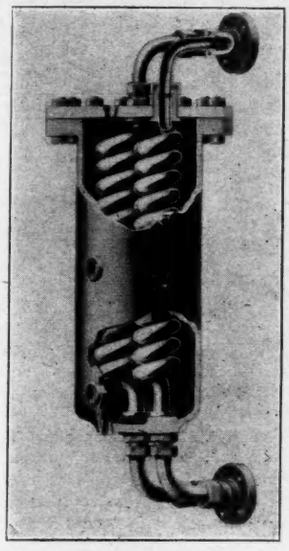
It is intended to feed both the Evanston and Park Ridge substations over this line. Power was previously supplied to the Park Ridge line over the existing line from the Evanston substation. The new connection will make improvements in the service to both stations and will allow for increased load.

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

Coil-Type Heater for Fuel Oil.

Fuel oil which is now being furnished to foundries for use in cupolas is of a very heavy grade, and it is necessary to preheat this oil before it goes to the burners in order to insure proper vaporization. The Reilly fuel-oil heater has



Heater for Fuel Oil.

been designed by the Griscom-Russell Co., New York City, for the preheating of fuel oil. The special coil construction used results in high efficiency and eliminates the possibility of strains on coil joints. High-pressure steam is generally used for heating of this fuel oil, and the condensate is returned to the boilers. It is, therefore, important that precautions be taken to prevent contamination of this high-pressure condensate by the fuel oil. This is taken care of in a Reilly oil heater by the special connections which are so designed that there are no oil joints inside the steam space. Consequently the possibility of contamination of the steam condensate is eliminated.

Lite-a-While Lamp Socket.

A socket which keeps lighted after the switch is turned off has been developed by the Lite-a-While Socket Co., Minneapolis, Minn.

Prepay Attachment for Watt-Hour Meters.

For supplying energy to small consumers and a shifting population, such as that found at summer resorts, the type OA prepayment attachment for type OA watt-hour meters, recently placed on the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is said to be especially useful. By means of the attachment a standard single-phase watt-hour meter can be converted into a prepayment meter, and, if desired, it can be changed back to a standard meter by replacing the standard register and cover.

The prepayment attachment mechanism is entirely mechanical. By placing a quarter in the top of the coin chamber and turning the knob in the direction of the arrow the meter is made ready to give service as required by the consumer. This operation of the knob winds a clock spring which is unwound by gears at a speed depending upon the rate per kilowatt-hour for which the attachment is furnished. When the spring is completely unwound a quick-break switch is automatically opened and the customer is without energy until another quarter has been placed in the coin mechanism. The attachment can be supplied for rates of $0.04 to $0.25 per kilowatt-hour (full cents only). The attachment is designed to receive quarters in any number up to sixteen at one time, provided that the customer has no quarters already to his credit. A pointer always indicates on a marked dial the number of quarters that remain to the credit of the customer. When the customer has sixteen coins to his credit, the sixteenth coin automatically closes the coin chamber so that no more coins can be placed in the mechanism until electrical energy equal to the value of one or more quarters has been used. The coin chamber will hold approximately $6.25 in quarters.

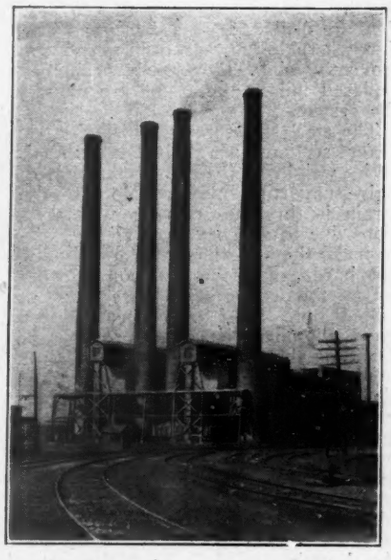
With the aid of the scale marked on the cover and surrounding the indicating dial it is possible to determine the number of quarters that have been placed in the meter by observing the position of the zero on the dial with reference to the numbers on the fixed scale on the cover. Knowing the number of quarters and the rate per kilowatt-hour, the number of kilowatt-hours can be determined. If it is not desirable to determine in this manned the kilowatt-hours used by the consumer, the attachment can be supplied with a small three-dial register reading direct in kilowatt-hours.

Steam-Jet Ash Conveyor With High Capacity.

The use of the steam-jet ash conveyor is rapidly growing among central stations throughout the country. It has so many obvious advantages that it is being classified as standard equipment by many power-plant executives. Reduced labor costs, ease and simplicity of operation and moderate first cost are factors in its favor. One of the criticisms of the steam-jet ash conveyor has been its inability to handle a large tonnage of ashes through any one system. While this criticism may, perhaps, not be a serious one for the average plant, there are a number of large central stations throughout the country whose special conditions require an effective high-duty conveyor.

The problem of meeting this demand has engaged the attention of ash-disposal engineers from time to time, and after repeated experiments and considerable study a high-duty ash conveyor with unusual capacity has been designed and placed on the market by the Conveyors Corp. of America, Chicago.

The first of these conveyors to be placed in successful operation was in the Cedar



Plant at Cedar Rapids, Ia., Where 9-In Ash Conveyor Is Used.

Rapids plant of the Iowa Railway & Light Co. The conveyor consists of a plurality of semicylindrical hard-metal pipes bolted to a steel frame to form a conveyor line of 9-in. internal diameter. Similar to the early types of steam-jet conveyors, it consists of an assembled line of pipe laid in a trench in the boiler room floor, or in the stoker tunnel, with intakes conveniently situated before the ash-pit doors.

The frame is made up of parallel bars of T and angle iron with uniform punching. The various sections such as pipe and intake fittings are bolted to this framework. One section fits into another longitudinally through the use of a tongue and groove. The joint between the section and the T iron is cemented, thus insuring air-tight construction. Over the joints between pipes or section lengths is bolted a cast-iron cap which is also cemented against air leakage. The steam units and impact elbows are built up of hard-metal sections which, in case of wear, can be easily and quickly replaced without disturbing other parts.

One of the features of the conveyor is the interior diameter of the pipe, this being full 9 ins. The area of the feeding opening is the full area of an 8-in. circle. The size of this conveyor was finally determined on after a consideration of several different internal diameters. The size chosen was believed to be the best adapted for large capacities, both as a matter of steam-operating cost, repair expense per ton of ash handled

and original cost. The 9-in. size involves a theoretical increase in feeding capacity of 38% over the more common 8-in. ash conveyor. In actual practice this capacity is said to be increased considerably. The 8-in. conveyor has an average feeding capacity of 6 to 8 tons of ash per hr. Under actual test at Cedar Rapids the new conveyor handled ashes at the rate of 15 tons per hr. from the intake nearest the steam unit. A conservative average for several intakes is given as 12 tons per hr.

Standardization of parts is said to be one of the important features of this equipment. Only standard sections of the new conveyor of 2 or 4-ft. lengths are used where the wear occurs on the conveyor. If sections of a definite length other than 2 or 4 ft. are used, they are ordinarily placed in the suction line where little wear occurs and consequently where they rarely need to be replaced unless alterations are made in the system.

The steel structure to which the conveyor sections are bolted carries the entire weight of the conveyor and is the only supporting means. No stress or strain is thrown on the conveyor sections due to support, making it possible to make these sections of a metal which has hardness as the first consideration. Since the conveyor half-sections are bolted onto an outside steel support, good alignment is said to result. Because of the exterior supporting means used the renewal of parts is a comparatively simple operation. The lugs on each conveyor half-section are staggered so that each section bolts independently to the steel work. In removing and placing a section it is only necessary to unbolt the half-section that needs replacing, and no other sections are interfered with. The end joints are made by throwing a rib around the end of each section. When two of the standard sections come together there are two ribs together, one on each section. Then a cast-iron cap is used which is filled with a special cement squeezed in to fill up the crevices and produce a tight joint at this point.

Longitudinal joints between the half-sections are made by a special cement which is held firmly in place. When the sections are drawn up by the bolts the cement used for side joints squeezes out and is then pointed up so that a cement gasket of considerable thickness is left.

In the new conveyor the intake opening is of such size that large pieces of clinker can be handled, making it unnecessary to break clinker any finer for this device than for most other types of mechanical conveying equipment. This not only facilitates the feeding but also increases the capacity that it is possible to carry per hour and decreases the amount of labor required in handling clinker into the conveyor. On account of the external supporting means used it is unnecessary to have fittings with bodies and interior liners. Consequently the fittings at the turn of the system are made up of sections which are in themselves wear parts, each of which is independently bolted to the steel structure. Because of the size of the conveyor, the size of the feeding opening, and the capacities that it is possible to handle in this size of conveyor it has been found that the steam consumption per ton of material handled has been lower than previously thought possible with steam-jet equipment.

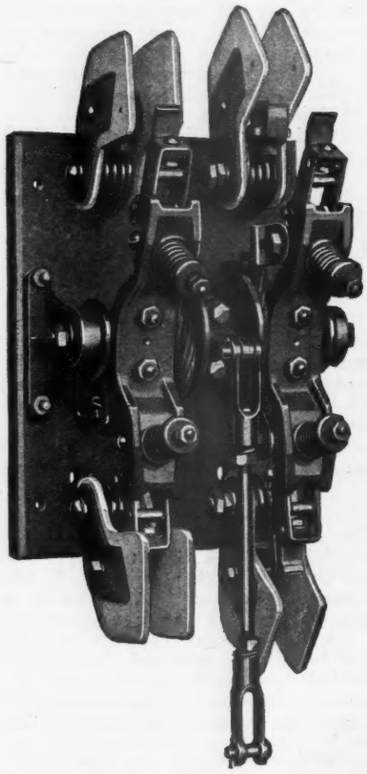
Cement for Mending Breaks in Heating Coils.

Much of the trouble and expense resulting from the burning out of coils in electric-range and other heating units is said to be eliminated by the use of a recently developed cementing material called "Carricite." In using this material it is necessary to make a good mechanical connection. In the case of open-coil-type range elements this can be done by overlapping two or three convolutions of the resistance wire. With other types of elements the ends can be twisted together thus making a good connection. It is not necessary to clean the wire at the splice. Current should then be turned on and a quarter of a teaspoonful of Carricite applied at the connection, keeping the Carricite in contact with the wire by pressing it down with a screw driver. A screw driver with a wooden handle should be used to eliminate danger of shock. If a "hot spot" appears after the Carricite is melted pressure can be applied at the connection with the end of a screw driver to complete the weld.

This material, which is made by the Carricite Co., Chicago, is put up in tubes 1.25 ins. in diameter by 3.5 ins. long.

Clapper-Type Controller With Compression Rheostats.

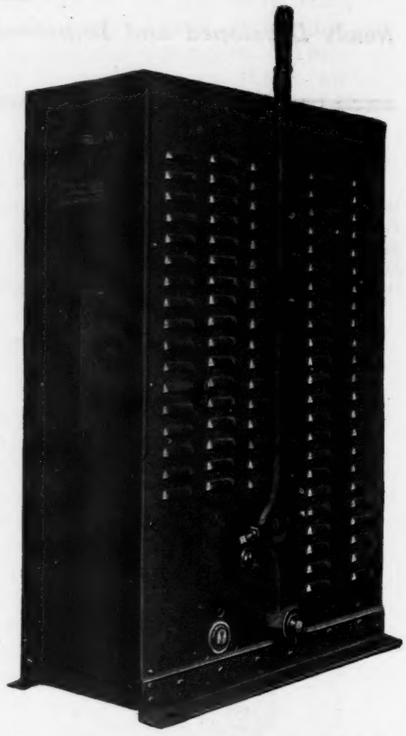
Allen-Bradley Co., Milwaukee, has developed a new line of mill, crane and hoist controllers to supplant its types Q, R and S controllers for the same service. The new controller, made in



Clapper-Contactor Unit for Controllers From 20 to 90 Hp.

sizes ranging from 1 hp. to 150 hp., is known as the "clapper-type controller," primarily because all switching and contact-making is done with a clapper-switch contactor.

The controller is further simplified by the use of the Allen-Bradley graphite compression resistor, mounted within the controller, avoiding the use of grids



Type F-2401, 150-hp. Controller Totally Inclosed.

or wire-wound resistors and the need of step contacts. All speed control is obtained by pressure variation upon the resistor column applied by the control lever.

The salient features of the new line of controllers, for either direct current or alternating current, may be summed up as follows:

Clapper contactors of copper-to-copper, rolling type are used exclusively to open and close the circuit.

Clapper switches, mounted inside the controller are mechanically operated and perform all switching up to 100 hp. Larger controllers use external magnetic clapper switches actuated from a pilot switch within the controller.

Graphite compression resistors supplant grid or wire resistors, thus simplifying wiring and inspection. The removal of a resistor is as simple as the removal of a cartridge fuse.

A single lever gives full control in either direction without steps or jumps, and also actuates the clapper contactors.

Steel frame construction is used with pressed steel inclosing covers, reducing the controller weight greatly.

Switch cams positively open and close the switch clappers in either direction as desired.

These controllers, applied extensively to crane and hoist control, as well as in turn-table service, mill control, and similar heavy duty work, offer many advantages over controllers of the face-plate or drum types by virtue of the simpler switch gear and compression resistor. Optional features are offered, such as underlever control gear, limit switch or brake connections, and inclosing covers for the resistor compartment.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Stanley & Patterson, 23 Murray street, New York City, have issued a 32-page catalog descriptive of the "Patterson" types of battery sets.

Stuart Products Corp., Chicago, manufacturer of batteries, has moved its offices to more commodious quarters at 665 West Washington boulevard.

Davis Slate & Manufacturing Co., 610 East 40th street, Chicago, producer of electrical slate and marble, is distributing to the trade an attractive office calendar.

Elliott Co., Jeanette, Pa., manufacturer of power accessories, has issued its catalog "C," illustrating and describing the company's line of jet and surface condensers.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., in a booklet on "Aerial Railway of Industry," describes the various equipment manufactured by the company.

Baylis Co., Bloomfield, N. J., has issued bulletin No. 516, entitled "Commutation Troubles and Their Elimination," which describes the reaction brush-holder equipment manufactured by the company.

F. B. Electric & Manufacturing Co., Detroit, has issued various folders descriptive of its test sets, battery testers, motor-generator sets, coil and magneto testers, discharge rheostats and battery-charging panels.

Ivanhoe-Regent Works of General Electric Co., Cleveland, has compiled in booklet form a series of advertisements appearing in widely distributed publications, demonstrating the value of good lighting in factories, stores and homes.

Harvey Hubbell, Inc., Bridgeport, Conn., has issued bulletins Nos. 16-18, 16-20 and 16-21, illustrating its No. 8121 toggle switch, No. 3916 pull socket with luminous acorn, No. 6725 pull chain with luminous acorn, No. 6720 cap, and No. 6712 attachment plug.

National Tube Co., Frick building, Pittsburgh, has issued bulletins No. 14-G and No. 7, the former covering "National" tubular steel poles and the latter describing the manufacture and advantages of "National" welding "scale free" pipe, a product which is used extensively for conduit purposes.

Robbins & Myers Co., Springfield, O., manufacturers of electric motors, generators and fans, has announced the appointment of Herbert T. Lewis as manager of the Philadelphia office of the company to succeed the late A. S. Tarr. Mr. Lewis entered the employ of the Robbins & Myers Co. in 1913 as a salesman in the Philadelphia office. The territory under his jurisdiction will include the states of Pennsylvania, Virginia, West Virginia, Delaware, Maryland, North and South Carolina, Georgia, Florida, southern New York and eastern Tennessee.

International Electric Co., Indianapolis, Ind., manufacturer of electrical heating appliances, etc., has moved its office and factory to the five-story building at 211-15 South McCrea street.

American Di-Electrics, Ltd., 95 Liberty street, New York City, has announced the appointment of E. A. Thornwell, Atlanta Trust Co. building, Atlanta, Ga., as its agent for the southern states.

Westinghouse Electric Products Co., Mansfield, O., has recently completed a new five-story building which will double productive capacity. Offices will be located on the fifth floor with the warehouse on the fourth floor, connected to the shipping room on the first floor by means of a spiral chute. The second and third floors are devoted to electric ware assembly. In addition to the new building a third floor is being added to the older building for use as a cafeteria.

New Building of Westinghouse Electric Products Co. at Mansfield, O.

P. A. Geier Co., Cleveland, has an item on the subject of selling electric-cleaner attachments in the December issue of its dealers' house-organ "Royal Breezes." It is pointed out that the offer of attachments is too frequently an after-thought on the part of the salesman and that more successful results will follow if the cleaner and attachments are presented to the housewife as a complete cleaning service rather than as a machine with accessories.

Frederick Engineering Co., Frederick, Md., has received a contract from the Lord Construction Co., 105 West 40th street, New York City, for the installation of two Frederick underfeed stokers of seven retorts each in its high-pressure dry-dock plant at West New York, N. J.; also six five-retort stokers to be installed on 500-hp. Wickes boilers in the United States army station plant at Lakehurst, N. J.

Crouse-Hinds Co., Syracuse, N. Y., has issued bulletin 1000-R on its condulet fixture joint and extensions for suspended type fixtures.

Hochbaum-Hylander Electric Co., 539 Central avenue, Newark, N. J., manufacturer of electrical products, has filed notice of dissolution under state laws.

Louisville Electric Manufacturing Co., 660 South Second Street, Louisville, Ky., plans to erect a one-story plant, 60 by 150 ft., for the manufacture of portable electric tools, etc.

Simplex Wire & Cable Co., Boston, has announced the appointment of the E. S. Stickle Co., Pittsburgh, as its representative in the Pittsburgh district to succeed the Stickle & Taylor Co., which has been dissolved.

Delta-Star Electric Co., 2433 Fulton street, Chicago, has issued a leaflet describing its 40,000-lb. testing equipment for mechanical testing insulators, bus supports and switches designed to withstand large mechanical stresses.

American Ever Ready Works of National Carbon Co., Inc., Long Island City, N. Y., reports the greatest demand in its history among the retail trade for "Eveready" flashlights to be sold as Christmas gifts. Attention is being called by the company through its dealer helps to the fact that the nickel types of flashlights make suitable presents for this season of the year.

Chase-Shawmut Co., Newburyport, Mass., manufacturer of soldering flux, etc., has announced the appointment of H. C. Moran, Keystone building, Pittsburgh, as district representative for western Pennsylvania, West Virginia, Ohio and Kentucky. The Engineering Equipment Co., Philadelphia, has been appointed district representative for New Jersey, Maryland and eastern Pennsylvania.

American Radio & Research Corp., 21 Park Row, New York City, recently completed a $300,000 addition to its new factory at Medford Hillside, Mass., increasing its factory space about 20,000 sq. ft. The new building is of the latest concrete and steel construction and will be utilized for the production of fractional horsepower motors, in addition to the established line of amateur wireless apparatus.

Lewis & Roth Corp., 13th and Wood streets, Philadelphia, has announced a change in name to the Electric Power Equipment Corp. The new name has been chosen as one more indicative of its field of activity. This change affects the name only, the personnel practically remaining the same, as does the sales policy and manufactured products. All apparatus which was formerly manufactured by the Lewis & Roth Corp. will hereafter be designated as the "Elpeco" lines of equipment.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

C. D. DARETT has succeeded R. C. Smith as manager of the Texas Telephone Co., Ennis, Tex.

D. A. BLODGETT has been elected treasurer of the Litscher Lite Corp., Grand Rapids, Mich., to succeed T. J. Barker, who has resigned.

R. A. SCHUYLER, formerly foreman of the Great Falls (Mont.) plant of the Montana Power Co., has been promoted to the position of manager of the Bozeman office.

E. B. EDWARDS has been promoted from the position of cashier of the Northampton Electric Lighting Co., Northampton, Mass., to assistant manager of the company.

EDWARD WHALEY, formerly in charge of the northern district of California for the Pacific Gas & Electric Co., San Francisco, is now connected with the Baymiller-Post Co.

H. D. STOKES, who has been elected chairman of the Worcester Electrical Contractor-Dealers' Association, is power engineer for the Worcester Electric Light Co., Worcester, Mass.

GEORGE HUGHES, Truscon Steel Co., Youngstown, O., spoke on the subject of "Electric Welding" before the Pittsburgh Section, Association of Iron and Steel Electrical Engineers, Dec. 18.

WILLIAM C. BRENNAN, formerly assistant superintendent of construction of the Merchants Heat & Light Co., Indianapolis, Ind., has been appointed foreman of the construction division.

H. I. ROBINSON, formerly with the Universal Machine Co., Baltimore, has joined the engineering staff of the Kleinschmidt Co., New York City, manufacturer of printing telegraph apparatus.

R. E. KINHEAD, formerly mechanical engineer in the welding department of the Lincoln Electric Co., Cleveland, has become connected with the technical staff of the Mitchell Co., Chicago.

W. H. GLENN, who has been vice-president and operating manager of the Georgia Railway & Power Co., Atlanta, Ga., since 1904, has resigned to accept the presidency of the Shippers Compress Co.

NEWTON WILLIS, who recently left the employ of the Merchants Heat & Light Co., Indianapolis, Ind., for a position with the Speedway Aviation Depot, is again connected with the company as engineer at the West plant.

CHARLES A. MUNROE, vice-president of the Public Service Co. of Northern Illinois, was elected president of the American Gas Association at the annual meeting of that organization held in New York City last month.

A. K. CHAMBERS has been appointed manager of the Chicago office of the American Bosch Magneto Corp., Springfield, Mass. He was formerly connected with the general sales department of the company at Springfield.

DAVID S. WEGG, JR., has become associated with W. A. Gilchrist, Chicago, as electrical engineer. He was formerly in the employ of the Allis-Chalmers Manufacturing Co., Milwaukee.

FRED K. GEORGE, assistant to the president, United Light & Railways Co., Grand Rapids, Mich., was the speaker at a recent meeting of the Davenport (Ia.) Advertising Club, his subject being "The Value of Advertising to a Public Service Corporation."

S. B. IRELAN, who was elected president of the Southeastern Geographic Division of the National Electric Light Association at the annual

S. B. Irelan.

convention of that organization held recently in Miami, Fla., is vice-president and general manager of the Montgomery (Ala.) Light & Water Power Co., one of the Henry L. Doherty & Co. properties. He graduated from Purdue University as an electrical engineer and was connected with the engineering department of the Denver (Colo.) Gas & Electric Co. for two years, and for a similar period he was engaged in engineering work in the New York office of the Doherty organization. Later he was appointed secretary-treasurer of the Fremont (Neb.) Gas & Electric Co., vice-president and general manager of the City Light & Traction Co., Sedalia, Mo., and vice-president and general manager of the Bartlesville (Okla.) Gas & Electric Co., all Doherty properties. Mr. Irelan is 31 years of age and holds membership in the National Electric Light Association, American Gas Association, University, Rotary and Country Clubs of Montgomery, Ala. He is also a member of the executive committee of the Alabama Light and Traction Association, and the board of directors of the Doherty Men's Fraternity.

R. J. WENSLEY, of the switchboard engineering department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., spoke Dec. 17 on the subject of "Automatic Substations" before the St. Louis Section, American Institute of Electrical Engineers.

L. F. ADAMS, electrical engineer of the power and mining department, General Electric Co., Schenectady, N. Y., delivered an address on "Continuous Rated or 50-Deg. Rise Motors" before the Cleveland section of the Association of Iron and Steel Electrical Engineers at Cleveland on Dec. 13.

OBITUARY.

CHRISTOPHER A. SHEA, Boston, Mass., an inventor of electrical apparatus and an expert telegrapher, died last month at the age of 50 years.

E. I. BARTLETT, sales manager of the Bryant Electric Co., Bridgeport, Conn., died last month. He was 38 years of age and a graduate of Clark College, Worcester, Mass.

CARL K. BADGER died in Boston Nov. 25, aged 38 years. He was assistant production manager of the General Electric Co., Pittsfield, Mass., and had been connected with the company 22 years, being employed at the Schenectady (N. Y.) plant before going to Pittsfield.

FRANCIS L. STETSON, attorney for the Niagara Development Co., United States Rubber Co. and many railroad companies, died at his home in New York City Dec. 5. Mr. Stetson was one of the leaders of his profession in the United States and was for years a partner of the late ex-President Grover Cleveland.

J. H. HONS, general auditor of the Bell Telephone Co. of Pennsylvania, died last month in Philadelphia. He entered the service of the Bell system in 1895, as an employe of the New York & New Jersey Telephone Co., being appointed general bookkeeper of that company in 1905. In 1911 he became connected with the Bell Telephone Co. of Pennsylvania as division auditor of receipts, being later promoted to general auditor, which position he held at the time of his death.

FREDERICK B. EAVES, assistant general sales manager of the Bryant Electric Co., Bridgeport, Conn., died Dec. 12. He was a graduate of Harvard University, class of 1905, and had been connected with the Bryant company for over nine years, being field representative in New England and New York state until 1918. During the war he served in the electric power and equipment division of the War Industries Board, having charge of the question of essentials as it related to the electric jobbing industry of the country. Soon after the armistice he returned to the service of the Bryant company and in 1919 made an extended trip through Europe as a special representative of its export department.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Bangor, Me.—The Bangor Railway & Lighting Co., has filed plans for extensions and improvements in its electrically operated pumping station, 70 by 70 ft., at Old Town, Me., to cost about $17,000. Edward Graham is president and manager.

Belfast, Me.—The International Radio Telegraph Co., has arranged for the establishment of a wireless station on a local site. The company has property totaling over 150 acres, and the initial plant will be enlarged and extended at a later date.

Bennington, N. H.—Considerable electrical and mechanical equipment will be installed in the new three-story mill for the Monadnock Paper Mills at Bennington. The structure will be 100 by 100 ft., and is estimated to cost about $100,000.

Boston, Mass.—The Department of Public Utilities has inaugurated a series of public hearings relative to the rates of service now charged by the Boston Electric Illuminating Co. The maximum rate at the present time for any class of service is 12 cents per kw-hr.

Brookline, Mass.—The New England Telephone & Telegraph Co., 50 Oliver street, Boston, has filed plans for extensions and improvements in its local exchange plant on Marion street, to cost about $35,000.

Brockton, Mass.—The Edison Electric Illuminating Co., has made application to the Department of Public Utilities for permission to issue stock to the amount of $594,090, the proceeds to be used for payment of additions and improvements to the company's property.

South Egremont, Mass.—In connection with extensions and improvements at its local stone-crushing plant, estimated to cost about $100,000, the Berkshire Stone Products Co. will construct a new transmission line for power service at its properties. The new line will be about 1 mi. in length.

Taunton, Mass.—The city council has completed plans for extensions and improvements in the municipal electric lighting plant to cost about $75,000. Jackson & Moreland, 387 Washington street, Boston, are architects.

Worcester, Mass.—The New England Power Co. has been granted permission by the Department of Public Utilities to issue bonds for $550,000, the proceeds to be used for payment of extensions and betterments in the company's electric power plants and system.

Wrentham, Mass.—Electrical and mechanical equipment will be installed in the new cold-storage plant to be erected by the State Department of Mental Diseases at the Wrentham State School, Wrentham. The new plant will be one-story, 52 by 67 ft.

Bridgeport, Conn.—The city engineering department has inaugurated construction of two new electrically operated pumping plants for waterworks service, each one-story, located on Inland Brook avenue, and estimated to cost $30,000 each.

Stamford, Conn.—The Southern New England Telephone Co., will call for bids soon after the first of the year for the erection of its proposed two-story and basement exchange plant on local site. It will be 40 by 100 ft., steel and hollow tile construction. L. W. Robinson, New Haven, Conn., is architect.

Woonsocket, R. I.—Electric motors, electric-operated machinery and other electrical apparatus will be installed in the new three-story spinning mill for the Myanza Mills, manufacturers of textiles. The plant will be 150 by 347 ft., and estimated to cost about $700,000.

Albany, N. Y.—The State Hospital Commission is arranging for the installation of electrically operated laundry equipment in the state institutions at Hudson and Brooklyn, N. Y. E. S. Elwood is secretary.

Brooklyn, N. Y.—The Brooklyn Edison Co. has been granted permission from the Public Service Commission to issue bonds for $8,000,000. The proceeds will be used for electric plant and system extensions and betterments; of the amount, $3,400,000 will be used for new work, and the remainder of the fund for reimbursement of company's treasury of past expenditures of this character. The company has arranged for the immediate disposition of $5,000,000 in bonds of the total authorized.

Cadyville, N. Y.—The International Paper Co., 30 Broad street, New York, has plans under way for the erection of a hydroelectric power plant on the Saranac river, near Cadyville, to be used for paper mill operation in this section. The proposed plant is estimated to cost about $250,000, including machinery.

New York, N. Y.—Plans for the operation of city-owned cars on the lines of the Staten Island & Midland Railway Co., are being perfected and the cars recently purchased by the city are expected to be ready for service about Dec. 1. Additional electrical apparatus will be installed as required.

New York, N. Y.—The Bonright Securities Corporation, specializing in utility securities and properties, has filed notice of increase in capital to $1,000,000.

New York, N. Y.—The Electric Transport Co. has filed notice of increase in capital from $100,000 to $750,000 for general expansion.

New York, N. Y.—The New York Telephone Co. is completing plans and will soon take bids for the erection of an eight-story exchange building at Willoughby avenue and Bridge street, Brooklyn, to cost about $1,000,000. McKenzie, Voorhees & Gmelin, 1123 Broadway, are architects.

New York, N. Y.—The San Juan Light & Transit Co., Room 932, 30 Broad street, is arranging for a dissolution of the company. T. A. Spoor is secretary.

New York, N. Y.—The United Electric Light & Power Co. has had revised plans prepared for the erection of its proposed electric generating plant at 134th street and East river. The plant will comprise two main buildings, and is estimated to cost about $2,500,000, with equipment.

Owego, N. Y. — The Owego Light & Power Co. is arranging for the construction of an addition to its local power plant for increased capacity. Application for permission has been made to the Public Service Commission.

Rossie, N. Y.—The Rossie Electric & Manufacturing Co. plans the further development of the electric property at Rossie. The company plans to repair and rebuild the dam at Indian river, head gates and flume, install additional water wheel, generator, and other equipment, to cost about $23,000. Dr. A. T. E. Young is director of the company.

Sayville, L. I. C., N. Y.—The Bureau of Yards & Docks, Navy Department, Washington, has awarded a contract to the F. G. Fearon Co., 280 Madison avenue, New York, for the erection of a new building at its radio station at Sayville.

Shushan, N. Y.—The local electric light plant was recently destroyed by fire, and the loss is estimated at $8,000.

Maurer, N. J.—The Barber Asphalt Paving Co., Land Title building, Philadelphia, is taking bids through its engineers, Lockwood, Greene & Co., 101 Park avenue, New York, for the rebuilding of its local plant, recently destroyed by fire with loss estimated at close to $1,000,000. The works will include a large central electric power plant for general plant service, and considerable electrically operated machinery.

Newark, N. J.—A resolution approving a city owned power plant was adopted by the Federation of Improvement Associations.

Newark, N. J.—The subject of municipal power plants will be discussed before the Federation of Improvement Associations, by City Commissioner Raymond and F. W. Ballard of Cleveland, O.

Trenton, N. J.—City Commissioner Page is arranging for an appropriation of $25,000 for extensions and improvements in the local electric lighting system. It is proposed to install a number of new high-power lamps in different parts of the city, and new lamps in Upper Stacy park.

Mt. Holly Springs, Pa.—Approval has been asked of the Public Service Commission for the formation of the

Cumberland Valley Light & Power Co., to comprise a merger of six utility corporations chartered and operating in the vicinity of Mt. Holly Springs and other points in Cumberland County. The companies are: M. E. Kraybill Light, Heat & Power Co.; Carroll Township, Monroe Township, Upper Allen Township, South Middleton Township and South Mountain Electric Companies. Headquarters for the new organization will be established at Harrisburg.

Plymouth Meeting, Pa.—The American Magnesia Co. has extended its electric system to serve residents along the Plymouth road. All machinery at the company's plant has been arranged for electric operation.

Plymouth Meeting, Pa.—The H. W. Johns-Manville Co., Madison and 41st street, New York, will install considerable electrical equipment in connection with its new local limestone quarries and lime plant.

Scranton, Pa.—The Delaware, Lackawanna & Western Railroad Co. is completing final surveys for the electrification of its lines east and west of this city. Plans have been prepared and it is proposed to place the work under way at an early date.

Shenandoah, Pa. — The borough commission has arranged for the immediate construction of a electrically operated pumping plant to cost about $30,000.

Baltimore, Md.—In connection with plans for the erection of a large addition to the Johns Hopkins Hospital, the Board of Directors has arranged an appropriation of from $100,000 to $500,000, as required, for the construction of an electric power plant at the institution, including the installation of electrical equipment in various parts of the structure, as required.

Baltimore, Md.—The Board of Directors, Union Memorial Hospital, is planning the erection of a power plant in connection with the new hospital to be erected. Charles L. Reeder, Park avenue and Saratoga street, is electrical engineer for the project.

Baltimore, Md.—The Consolidated Gas, Electric Light & Power Co. has plans under way for the erection of an addition to its substation on Front street. The new plant will occupy the entire frontage of Madison street block, between Constitution and Graves street.

Baltimore, Md.—The Miller Safe Co. is building a power plant at its new factory at Wilkens avenue and Catherine street. A 50-ft. stack will be provided.

Baltimore, Md.—The Wizard Check Indorser & Printing Machine Co., Calvert building, will build an electric power plant at its proposed new factory in the Highlandtown district. The first unit of the factory, with power plant, is estimated to cost about $300,000. F. S. Weise is president.

Washington, D. C.—Bids will be received Dec. 22 for electric conduit and wiring in tunnels, and extension of outside lighting at U. S. Hospital No. 22, 2650 Wisconsin avenue. Jas. A. Wetmore, architect, is acting supervisor.

Washington, D. C.—The Department of Agriculture, in co-operation with the Bureau of Standards, is planning the construction of about 17 wireless stations in different parts of the country for carrying agricultural news to farmers in outlaying districts. The initial plants will be installed in sections of Maryland and Virginia, and work on these structures will be placed under way at an early date.

Durham, N. C.—The Southern Power Co., a New Jersey corporation, has filed notice of increase in capital from $11,000,000 to $15,000,000 for general expansion.

Lenoir, N. C.—The Granite Falls Manufacturing Co. will construct a power house, dam and transmission line.

Mortimer, N. C.—The United Mills Co. will erect a power house, dams, transmission lines, etc., for public service and for the operation of a cotton mill. H. J. Holbrook, Holbrook, N. C., is secretary.

Spruce Pine, N. C.—D. A. Adams, Old Fort, N. C., is organizing a company to establish a hydroelectric power plant in the vicinity of Spruce Pine for local service in this district. A site has been selected on the Toe river.

Lockhart, S. C.—The Lockhart Power Co. plans to erect a hydroelectric power plant on the Broad river, with an initial capacity of 15,000-hp. Address Emslie Nicholson, president.

Sandersville, Ga.—The city council has arranged a bond issue of $40,000, to be used in part for extensions and improvements in the municipal electric power plant.

NORTH CENTRAL STATES.

Dayton, O.—The Dayton Power & Light Co. has been given permission by the Public Utilities Commission of Ohio to purchase for $35,000 the electric light plant of Walter D. Wise, located in Dayton.

Lodi, O.—The Public Utilities Commission of Ohio has authorized the Lodi Light & Power Co. to issue $20,000 of common capital stock to be sold at not less than par value, the proceeds to be used to purchase the electric light plant of Henry Bennander at this place.

Blissfield, Mich.—A special election will be held Jan. 11th to vote on the question of a bond issue of $30,000 for improving the electric light plant.

Holland, Mich.—The board of public works has plans to provide the north side electric lamps, provided forty people can be secured who will install them.

Three Rivers, Mich.—Two street lamps on River drive between Wood and Middle streets will be installed. O. O. Johnson is city manager.

Mellott, Ind.—The village is without electric lighting, and to provide for this necessity Mellott and Hillsboro have united and organized a stock company with a capital of $15,000.

Quincy, Ill.—The Lions club has secured $10,000 toward the lighting of Sixth street to the Wabash passenger station, and for the extension of the lighting system to the C. B. & Q. station. George Thompson is chairman of the campaign committee.

Eau Claire, Wis.—A petition for a "white way" on Water street from Third avenue to Fifth avenue, has been filed with the city council. The Wisconsin Minnesota Light & Power Co. will furnish the poles, the city will pay one-third of the expense of maintenance, and the abutting property owners will pay the other two-thirds.

Minneapolis, Minn.—The committee on public lighting of the city council, is considering a proposal by Alderman A. R. Gisslen to substitute arc lamps, for gas lamps, for the street lighting system in 1922.

Sauk Center, Minn.—The People's Electric Service Co. will install electric light and power on farms near here, and Grey Eagle.

Cedar Rapids, Ia.—The city will install Tungsten lights on the following intersections: 12th street and H avenue west, 18th street and A avenue west; 26th street and 4th avenue east, 6th street west, between O. and Penn. avenues. L. J. Storey is city clerk.

Blairstown, Mo.—The city will install an electric light plant, for which bonds will be voted upon. The mayor is in charge.

Blairstown, Mo.—The town commission is planning the installation of an electric system for general service. D. E. Sheppard is manager.

Crane, Mo.—The Lawrence County Water, Light & Cold Storage Co. of Aurora, will install an electric lighting system here.

Fulton, Mo.—The city will erect a power plant. The mayor is in charge.

Independence, Mo.—The sum of $20,000 is required to enlarge the present capacity of the local electric light plant.

Pineville, Mo.—The Ozark Electric & Mfg. Co., plans the erection of a hydroelectric power plant. The company was recently organized to furnish light and power service in this section. C. D. Resler is president.

Ottawa, Kan.—Bonds in the sum of $160,000 have been voted for the purpose of extending the local water and light plant.

Pleasantown, Kan.—E. T. Archer & Co., engineer, 609 New England building, Kansas City, has prepared plans for the erection of an electric light plant for Pleasantown. The city clerk is in charge.

Pleasantown, Kan.—The city electric light plant was recently destroyed by fire.

Wilsey, Kan.—C. M. Reid, engineer, Manhattan, has prepared plans for the improvement of the electric lighting system. A. R. Pirtle is the city clerk.

Milford, Neb.—Keening Hollister & Co., engineers, 401 Bankers Life building, Lincoln, have prepared plans for the electrical distribution system of Milford. The city clerk is in charge of the plans.

Menno, S. D.—The Menno Light & Power Co. was recently destroyed by fire, and the loss is estimated at $20,000.

Rugby, N. D.—The citizens are trying to arrive at some satisfactory arrangement with Mr. Waage, the new owner of the Rugby electric light plant for the continuation and improvement of the local plant.

SOUTH CENTRAL STATES.

Bloomfield, Ky.—The Bloomfield Utilities Co. has purchased an established plant, and will install an oil-

engine drive, 150 to 200 hp.; 14 miles of transmission; change the direct-current system to alternating current connecting Bloomfield, Wakefield and Fairfield, and extend their service to Taylorsville. Harry Peet, Jr., is proprietor of the company.

Carrolton, Ky.—Bonds in the sum of $12,000 have been voted, for the purpose of improving the power plant and water works. J. E. Gallon is mayor.

Virgie, Ky. — The J. B. Elkhorn Coal Co., is planning the erection of an electric power plant at its properties.

Walton, Ky.—Citizens have voted bonds for $10,000 for improvements in the electric lighting plant and system.

Birmingham, Ala.—Frank W. Nickelson, engineer, 70 E. 45th street, New York City, has prepared plans for the construction of a fire alarm system, which will include 30 miles of underground work; 200 miles of overhead construction, and the installation of 40 additional boxes, etc. The cost is estimated at $174,000.

Macon, Miss.—The city engineering department has plans under way for extensions and improvements in the municipal electric plant and waterworks system to cost about $25,000. J. J. Scott is city clerk.

Macon, Miss.—The city will improve and repair the water and light plants, for which bonds in the sum of $25,000 have been voted. J. J. Scott, clerk, is in charge of the plans.

Pascagoula, Miss.—The city council has plans under way for the erection of a new municipal electric power plant, for which bonds in the sum of $25,000 were recently approved.

Big Heart, Okla.—The Big Heart Light & Power Co., recently incorporated, will install a transmission line to develop 500-hp. P. J. Minck is in charge of the plans.

Enid, Okla.—Black & Veatch, engineers, 701 Mutual building, Kansas City, Mo., have prepared plans for 6 motor-driven deep-well pumps, which the city will install. R. T. Williams is the city clerk.

Bangs, Tex.—John Sanders is planning the installation of an electric light and power plant system.

Fort Worth, Tex.—Plans have been placed before Mayor W. D. Davis, for the erection of a power plant at Lake Worth with a water turbine to impound waters of the spillway for the generation of electric power.

Fort Worth, Tex.—The Fort Worth Power & Light Co., is said to be considering plans for the erection of an addition to its local generating plant.

WESTERN STATES.

Roswell, N. M.—The Roswell Gas & Electric Co. will install new equipment, which will cost about $50,000.

Missoula, Mont. — The Flathead Valley Electric Co., of which M. S. Shields, Spokane, is president, has had plans prepared for an hydroelectric engine for the construction of dams and the installation of machinery, incident to the development of a power site on Flathead river.

Boise, Idaho.—The Acequia Mutual Electric Co. has been organized and will purchase electrical energy from the United States Reclamation Service, for distribution.

Juliaetta, Ida.—The electric light and power plant owned by Frank Vincent was destroyed by fire recently, the loss being estimated at $10,000.

Garfield, Utah.—The Utah Power & Light Co. of Salt Lake City, has applied for permission to extend its lines from Garfield to the new mill of the Utah Consolidated Mining Co., in Toeele county.

Centralia, Wash.—Bids will be received for the installation of cluster lights to be installed in the business district of the city. The cost is estimated to be between $21,000 and $24,000.

Chelan, Wash. — The Great Northern railway will build a power plant at the foot of Lake Chelan. The construction of a dam is planned, which will raise the lake about 12 ft. J. H. O'Neil, Seattle, Wash., is general manager.

Olympia, Wash.—The Washington Irrigating & Development Co., Seattle, has filed an application for a permit to erect a power project on the Columbia river at Priest Rapids.

Seattle, Wash.—Plans have been prepared by Robert Herzog Co., engineer, and Thomas Palmer, attorney of the Great Northern railroad, for a fuel oil plant for the generation of additional electric power.

Walla Walla, Wash.—E. B. Hussey, engineer, Seattle, has estimated the cost of a municipal lighting plant at $381,000, which will include ample power for lighting the streets and 734-kw. for commercial use.

Grants Pass, Ore.—The Reuben Mining Co. will develop 87 hp. to operate aid compressors and furnish light; dam of logs and rock: flume and ditch 8½ miles long; wood headgate; Pelton wheels and pipe. The cost is estimated at $10,000.

Sams Valley, Ore.—The Sams Valley Power Co. has been recently incorporated with Melta Pelton as president, and contemplates the distribution of electrical energy.

San Diego, Cal.—A power plant for the marine base is being constructed on the reservation to furnish light and power for the base. A transformer house to take care of overloaded power at the marine corps base is also contemplated.

Stockton, Cal.—The Western States Gas & Electric Power Co. will build a power dam seven miles below Martins ferry. The Electric Metals Co. has applied for permission to build a power dam at Slate creek, five miles above Weitchpec.

INCORPORATIONS.

Lewisburg, W. Va.—J. C. Boggs Motor & Light Co. Capital, $50,000. To manufacture automobile lighting equipment, etc. Incorporators: J. C. Boggs, John A. Littlepage and others.

Green Bay, Wis.—Gold Seal Storage Battery Co. Capital, $300,000. T. J. Best, E. J. Bolza and F. J. Mankin.

Beaver Dam, Wis.—Duplex Storage Battery Co. Capital, $350,000. Incorporators: William Petschel, Peter Kettenhofen and others.

Cromwell, Ind.—Norstrom Manufacturing Co. Capital, $500,000. To manufacture telephone lockouts and accessories. Incorporators: W. R. Wright, J. C. Kimmell, C. E. Seymour, N. R. Norstrom and others.

Hamilton, Can.—Hamilton Storage Batteries, Ltd. Capital, $30,000. To manufacture batteries, electrical equipment, etc. Incorporators: George Ballard, Alfred Hipkins, Otto Dinkel and others.

Lloyd, N. Y.—E. R. T. Corp. Capital, $150,000. To manufacture electrical and mechanical apparatus. Incorporators: R. Luthi, Kingston, N. Y.; E. Bachelet, J. Schuble and others.

Waterbury, Conn.—The W. J. McNellis Co., Inc. Capital, $75,000. To manufacture electrical equipment. Incorporators: W. J. McNellis, 196 Grand street; J. J. McNellis and others.

Trenton, N. J.—Electric Power Equipment Corp. Capital, $25,000. To manufacture electrical apparatus. Incorporators: F. W. Dinsmore, 709 Greenwood avenue.

Rockford, Ill.—Steel Utilities Corp. Capital, $50,000. To manufacture electrical products, etc. Incorporators: J. F. McCann, G. O. Morton, S. A. Stoop, 250 Mill street, and others.

Louisville, Ky.—Louisville Electric Manufacturing Co. Capital, $75,000. Incorporators: James E. Willey, William Watts and others.

FOREIGN TRADE.

[Addresses of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Electric Motors, etc. (34,099)—A mercantile firm in Finland desires to secure an agency for the sale of electric motors, accessories and appliances of every description. Reference.

Electric Train-Lighting Systems (34,109)—The managing director of an engineering firm in India desires to be placed in communication with manufacturers of electric train-lighting systems, with a view to promoting their sale in that country.

Electrical Fixtures (34,112) — A sales corporation in Canada desires to secure the representation of manufacturers for the sale on a commission basis of electrical fixtures. References.

Electrical Apparatus (34,140)—Catalogs and price lists, with discounts, of electric lightings and fixtures, generating and community lighting units of all sizes are requested by a firm in China. Shipping weights, measurements and quotations c. i. f. Hongkong should be given, or quotations f. o. b. American port. No reference offered.

Electrical Goods (34,134)—An inquiry has been received from a man in England wishing to secure the representation of firms for the maintenance of a permanent exhibit of American products, such as electrical goods, etc. References.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Offering of Great Western Power Co. Bonds.

E. H. Rollins & Sons, Chicago, are offering an issue of Great Western Power Co. general closed mortgage 8% convertible bonds, at 100 and interest, to yield from 8.35% to 10.75%, every bond to be called within ten years at 105 and interest.

Authority Given to Purchase Telephone Property.

The Chicago Telephone Co., in an order issued by the Illinois Public Utilities Commission, is authorized to purchase the Illinois property of the Central Union Telephone Co. for $15,500,000. The order provides that the property must be transferred in six months. It will add about 200,000 subscribers to the Chicago company's service. The Central Union's service extends to every city and large town in the state except those in the eight counties surrounding Chicago.

Standard Gas & Electric Co. and Subsidiaries.

Twelve months ended Oct. 31—	1920.	1919.
Gross earnings	$31,324,089	$26,504,601
Net earnings	11,038,916	9,764,302

These figures do not include earnings of the Shaffer Oil & Refining Company which for the year ended Oct. 31 were: Gross, $12,417,965; net, $4,286,321.

Tennessee Power Co.

	1920.	1919.
September gross	$ 208,192	$ 161,296
Net after taxes	70,500	20,616
Surplus after charges	16,111	*23,017
Twelve months' gross	2,372,002	2,247,253
Net after taxes	963,239	883,419
Surplus after charges	319,692	238,870

*Deficit.

Southern Utilities Co.

	1920.	1919.
September gross	$ 221,490	$ 166,280
Net after taxes	35,917	28,985
Total income	35,963	29,266
Surplus after charges	17,449	13,084
Twelve months' gross	2,515,092	1,855,727
Net after taxes	473,889	157,168
Total income	475,079	158,166
Surplus after charges	260,100	*27,046
Balance after preferred dividends	259,804	*27,406

*Deficit.

Nashville Railway & Light Co.

	1920.	1919.
September gross	$ 279,189	$ 274,181
Net after taxes	9,376	69,125
Deficit after charges	31,072	*30,021
Twelve months' gross	3,564,495	3,150,791
Net after taxes	684,644	802,174
Surplus after charges	205,030	329,200
Balance after preferred dividends	80,030	204,200

*Surplus.

Adirondack Power & Light Corp.

	1920.	1919.
September gross	$ 435,405	$ 332,583
Net after taxes	63,238	138,312
Deficit after charges	27,838	*84,380
Twelve months' gross	4,520,709	3,808,801
Net after taxes	1,426,416	1,418,095
Surplus after charges	697,207	807,194

*Surplus.

American Power & Light Co. and Subsidiary.

	1920.	1919.
October gross	$2,093,140	$1,458,914
Net after taxes	651,976	533,781
Twelve months' gross	20,684,968	15,649,616
Net after taxes	7,217,566	5,801,919

Manila Electric Railroad & Lighting Corp.

	1920.	1919.
October gross	$ 327,608	$ 242,432
Net after taxes	124,050	77,436
Total income	124,094	77,444
Surplus after charges	85,899	41,043
Twelve months' gross	3,307,546	2,521,357
Net after taxes	1,083,291	882,130
Total income	1,085,574	883,357
Surplus after charges	696,833	563,757
Balance after preferred dividends	396,833	263,757

Northern Ohio Electric Co. and Subsidiaries.

	1920.	1919.
October gross	$ 899,926	$ 796,765
Net earnings	217,961	241,088
Surplus after charges	16,523	70,787
Deficit after preferred dividends	13,476	*40,787
Ten months' gross	9,308,961	7,528,102
Net earnings	2,714,628	2,531,304
Surplus after charges	816,150	857,197
Balance after preferred dividends	516,150	557,197

*Surplus.

Utah Power & Light Co. and Subsidiary.

	1920.	1919.
October gross	$ 571,387	$ 487,491
Net after taxes	259,664	227,777
Total income	274,337	238,802
Surplus after charges	129,665	102,678
Twelve months' gross	6,432,720	5,604,634
Net after taxes	2,952,908	2,825,349
Total income	3,096,916	2,967,547
Surplus after charges	1,408,938	1,259,967
Balance after preferred dividends	817,438	702,159

Duquesne Light Co. and Subsidiaries.

	1920.	1919.
October gross	$1,352,187	$ 972,527
Net after taxes	346,527	295,307
Ten months' gross	12,200,527	9,684,754
Net after taxes	3,555,338	3,408,432

Southwestern Power & Light Co. and Subsidiary.

	1920.	1919.
October gross	$ 979,792	$ 592,464
Net earnings	329,020	209,785
Twelve months' gross	9,039,898	6,180,999
Net earnings	3,319,788	2,179,538

Northern States Power Co.

	1920.	1919.
October gross	$1,081,099	$ 897,840
Net earnings	376,231	354,752
Twelve months' gross	11,277,738	9,605,741
Net earnings	4,346,011	4,090,734

Philadelphia Co. and Subsidiary.

	1920.	1919.
October gross	$1,062,727	$ 731,806
Net after taxes	529,604	160,695
Ten months' gross	12,048,576	9,839,768
Net after taxes	6,632,489	4,252,867

Portland Railway, Light & Power Co.

	1920.	1919.
October gross	$ 862,267	$ 725,635
Net after taxes	316,876	248,605
Surplus after charges	112,784	60,446
Twelve months' gross	9,283,345	8,480,008
Net after taxes	2,889,152	2,909,518
Surplus after charges	519,327	635,880

Dividends.

	Term.	Rate.	Payable.
Allis-Chalmers com.	Q	1½%	Feb. 15
Allis-Chalmers pfd.	Q	1.75%	Feb. 15
Cent. States El. pfd.	Q	1.75%	Dec. 31
Can. Crock-Wheel com.	Q	1.75%	Dec. 31
Can. Crock-Wheel pfd.	Q	1.75%	Dec. 31
Dayton Pr. & Lt. com.		$4.00	Dec. 20
Dayton Pr. & Lt. pfd.	Q	$1.50	Jan. 3
El. Lt. & Pr. (Mass.)	SA	$4.00	Jan. 3
El Paso El. pfd.	SA	$3.00	Jan. 10
Manh. El. Supply com.	Q	$1.50	Jan. 1
Manila El. R. R. & Lt.	Q	1.75%	Jan. 3
Okla. Gas & El. pfd.	Q	1.75%	Dec. 15
Spring. Ry. & Lt. pfd.	Q	1.75%	Jan. 1
U. Gas Impr.	Q	1%	Jan. 15
Un. Lt. & Ry. pfd.	Q	1.50%	Jan. 2
West. Elec.	Q	$2.50	Dec. 31

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Dec. 7.	Bid Dec. 14.
Adirondack Electric Power of Glens Falls, common	6	12	11
Adirondack Electric Power of Glens Falls, preferred	6	73	72
American Gas & Electric of New York, common	..	99	96
American Gas & Electric of New York, preferred	6	34	34
American Light & Traction of New York, common	..	108	105
American Light & Traction of New York, preferred	6	78	77
American Power & Light of New York, common	4	47	46
American Power & Light of New York, preferred	6	60	60
American Public Utilities of Grand Rapids, common	..	6	6
American Public Utilities of Grand Rapids, preferred	7	18	17
American Telephone & Telegraph of New York	..	98½	98
American Water Works & Elec. of New York, common	..	2	1½
American Water Works & Elec. of New York, particip	7	5	5
American Water Works & Elec. of New York, 1st preferred	..	39	38
Appalachian Power, common	..	2	2
Appalachian Power, preferred	7	18	16
Cities Service of New York, common	+extra	265	258
Cities Service of New York, preferred	6	64	63½
Commonwealth Edison of Chicago	8	101	100
Comm. Power, Railway & Light of Jackson, common	..	11	9
Comm. Power, Railway & Light of Jackson, preferred	6	33	32
Federal Light & Traction of New York, common	..	6	5½
Federal Light & Traction of New York, preferred	..	46	45
Northern States Power of Chicago, common	..	40	38
Northern States Power of Chicago, preferred	ex.div.7	76	75
Pacific Gas & Electric of San Francisco, common	..	48	47
Public Service of Northern Illinois, Chicago, common	7	61	60
Public Service of Northern Illinois, Chicago, preferred	6	80	79
Standard Gas & Electric of Chicago, common	..	11	10
Standard Gas & Electric of Chicago, preferred	8	33	32
Tennessee Railway, Light & Power of Chattanooga, common	..	½	½
Tennessee Railway, Light & Power of Chattanooga, preferred	6	2	2
Western Power of San Francisco, common	..	19	19
Western Union Telegraph of New York	extra	86	86
Industrials—			
Electric Storage Battery of Philadelphia, common	4	99	97
General Electric of Schenectady	8	125	120
Westinghouse Electric & Mfg. of Pittsburgh, common	7	43	42